Sub Working Group Outline on
Augmented Logistics and Smart Supply Chains

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Definition - Augmented and Smart Supply Chains

- **Augmented Supply Chain Definition**
  - Augmented supply chain refers to the integration and use of emerging technologies such as IoT, AI, 5G, blockchain, and other digital technologies into traditional supply chain processes. This integration aims to enhance visibility, improve operational efficiency, reduce costs, and provide greater transparency throughout the supply chain. Augmented supply chains use real-time data and analytics to monitor and track goods from suppliers to end customers, making it easier to identify bottlenecks, optimize operations, and improve overall performance.

- **Smart Supply Chain Definition**
  - Smart supply chain refers to a network of interconnected enterprises in a value chain that use digital technologies to exchange information deliver products or services to end-users. Smart-connected value chains leverage advanced technologies and digitalization infrastructure to make intelligent decisions by establishing provenance, traceability and market preference through trusted digital thread and data analytics. They adapt quickly to customer needs by anticipating demand, inventory levels, and logistics for assured supply. They enable marketplaces by leveraging the digital thread of data to manage vulnerabilities, establish market preference and create data-driven ML/AI applications and IoT services to maximize security and economic growth.

Sub Working Group Outline on
Augmented Supply Chain Logistics

Opportunities for IoT Augmented Supply Chain Logistics

- **Real-time monitoring and tracking:** IoT enables real-time monitoring and tracking of goods, assets, and equipment throughout the supply chain, increasing visibility, reducing delays, and improving operational efficiency.
- **Predictive maintenance:** IoT devices can monitor equipment performance, predict potential failures, and trigger proactive maintenance, minimizing downtime and disruptions in supply chain operations.
- **Enhanced inventory management:** IoT technologies facilitate better inventory management, enabling companies to optimize stock levels, reduce carrying costs, and minimize stockouts and overstocks.
- **Improved demand forecasting:** IoT devices can collect and analyze data on consumer behavior, market trends, and sales patterns, allowing businesses to make more accurate demand forecasts and adjust their supply chain operations accordingly.
- **Increased transparency and traceability:** IoT can provide greater transparency and traceability throughout the supply chain, enhancing trust and accountability among stakeholders and facilitating compliance with regulations and standards.

Opportunities for IoT Augmented Supply Chain Logistics

- **Automation and robotics:** IoT-enabled automation and robotics can increase productivity, reduce labor costs, and improve accuracy in supply chain operations, such as warehousing and material handling.

- **Enhanced transportation management:** IoT technologies can optimize transportation routes and schedules, monitor vehicle performance, and provide real-time updates on traffic and weather conditions, improving the efficiency and reliability of transportation networks.

- **Energy and resource efficiency:** IoT can help monitor and optimize energy consumption and resource use in supply chain operations, leading to cost savings and reduced environmental impact.

- **Improved collaboration and decision-making:** IoT-driven data sharing and analytics can enhance collaboration among supply chain partners, enabling better-informed decision-making and more agile response to changes in demand or supply conditions.

- **Enhanced risk management and resilience:** IoT can help businesses identify, monitor, and mitigate supply chain risks, such as disruptions, delays, or quality issues, enhancing the resilience and adaptability of their supply chain operations.

Global Automotive Supply Chain Process Steps Benefiting from IoT Technology – Raw Material Sourcing and Procurement

- **Tracking and tracing of raw materials:**
  - Leveraging technologies such as RFID tags, GPS, and sensors, manufacturers can gain real-time visibility into location and status of raw materials as they move through the supply chain.
  - Enhanced visibility allows manufacturers to optimize logistics, reduce lead times, and minimize stockouts or overstocking.
  - Provides assurance of responsible sourcing of materials, as well as compliance with environmental and regulatory standards.

- **Supplier performance monitoring:**
  - Potential to facilitate real-time monitoring of supplier performance in the automotive industry by installing sensors and other IoT devices at supplier facilities.
  - Manufacturers may remotely gather data on KPIs such as production rates, quality metrics, and delivery times enabling data-driven decisions regarding supplier selection and management, leading to improved supply chain efficiency.
  - May help manufacturers identify and address potential bottlenecks, quality issues, or other disruptions in the supply chain before they escalate into more significant problems.

- **Dynamic pricing and demand forecasting:**
  - By collecting and analyzing real-time data on factors such as market conditions, weather patterns, and consumer trends, IoT-enabled systems can help manufacturers make more accurate predictions about future demand for raw materials.
  - May enable adjustment of procurement strategies and negotiation of better prices with suppliers based on anticipated demand fluctuations.
  - Facilitates dynamic pricing models, where manufacturers and suppliers can negotiate prices in real-time based on changing market conditions and availability of raw materials, leading to more cost-effective procurement strategies.

Global Automotive Supply Chain Process Steps Benefiting from IoT Technology – Manufacturing and Production

- **Production line optimization:**
  - Deploying sensors and connected devices throughout the manufacturing process, manufacturers can monitor and collect real-time data on equipment performance, product quality, and worker productivity.
  - Enables predictive maintenance, where manufacturers can proactively maintain and repair equipment based on data-driven insights, reducing downtime and increasing overall productivity.
  - Facilitates implementation of automated and collaborative robots, streamlining processes, and improving production rates.

- **Quality control and assurance:**
  - Integrating sensors and other IoT devices into production lines enables manufacturers to automatically monitor and collect data on product quality at various stages of the manufacturing process.
  - Data can be used to identify defects, inconsistencies, or other quality issues in real-time, enabling manufacturers to take immediate corrective action and reduce the number of defective products reaching the market.
  - Additionally, IoT can help manufacturers track and trace root causes of quality issues, enabling continuous improvement.

- **Energy and resource management:**
  - Monitoring and analyzing real-time data from sensors and connected devices allows manufacturers to gain insights into energy consumption patterns and identify opportunities for optimizing energy usage.
  - IoT can also help manufacturers implement smart energy management systems that automatically adjust energy consumption based on production schedules, equipment utilization, and other factors.
  - Facilitates more effective resource management, such as tracking and monitoring water usage, waste generation, and emissions, enabling manufacturers to improve their sustainability efforts and meet environmental compliance requirements.

Global Automotive Supply Chain Process Steps Benefiting from IoT Technology – Warehousing and Inventory Management

- **Real-time inventory tracking:**
  - Utilizing technologies such as RFID tags, sensors, and GPS, manufacturers can obtain real-time visibility into the location, status, and condition of inventory items.
  - Real-time information enables manufacturers to optimize warehouse layouts, improve stock rotation, and reduce the risk of stockouts or overstocking.
  - IoT can help streamline inventory reconciliation processes, allowing for more accurate and efficient inventory management.

- **Warehouse automation:**
  - Deploying automated guided vehicles (AGVs), robots, and other IoT-enabled equipment allows manufacturers to automate various warehousing tasks such as picking, packing, and transporting inventory items.
  - IoT enabled automation reduces the reliance on manual labor and also minimizes the likelihood of human error in warehouse operations.
  - IoT technologies can enable the use of advanced warehouse management systems (WMS) that leverage real-time data to optimize warehouse processes and improve overall performance.

- **Predictive maintenance for warehouse equipment:**
  - Installing sensors on equipment such as forklifts, conveyor systems, and storage racks allows manufacturers to monitor equipment performance and detect potential issues in real-time.
  - Data can then be analyzed to predict when equipment is likely to fail or require maintenance, allowing manufacturers to proactively schedule repairs and maintenance activities.

Global Automotive Supply Chain Process Steps Benefiting from IoT Technology – Transportation and Logistics

- **Real-time tracking and monitoring:**
  - Equipping vehicles and shipments with GPS trackers, RFID tags, and sensors, manufacturers can obtain real-time visibility into the location, status, and condition of their goods as they move through the supply chain.
  - Enables manufacturers to optimize routing, monitor transit times, and proactively address potential delays or disruptions.
  - Can help manufacturers ensure the security of their goods and maintain compliance with regulatory requirements.

- **Fleet management and optimization:**
  - Collecting and analyzing real-time data from connected vehicles, manufacturers can gain insights into vehicle performance, fuel consumption, and driver behavior.
  - Data can be used to implement more efficient routing, reduce fuel costs, and improve overall fleet performance.
  - IoT can also facilitate predictive maintenance for vehicles, allowing manufacturers to proactively schedule maintenance and repairs based on data-driven insights, ultimately reducing vehicle downtime and extending the life of the fleet.

- **Smart logistics and dynamic decision-making:**
  - Leveraging real-time data from various sources, such as traffic conditions, weather patterns, and geopolitical events, IoT-enabled systems can help manufacturers make more informed decisions about their transportation and logistics strategies.
  - IoT can facilitate dynamic routing, where vehicles are automatically rerouted based on changing traffic conditions or other factors to minimize transit times and reduce transportation costs.
  - IoT can empower manufacturers to make data-driven decisions about their logistics partners, helping provide assurance they work with reliable and efficient providers.

Global Automotive Supply Chain Process Steps Benefiting from IoT Technology – Distribution and Order Fulfillment

- **Demand forecasting and inventory replenishment:**
  - By collecting and analyzing real-time data on consumer preferences, market trends, and regional sales patterns, IoT-enabled systems can help manufacturers make more accurate predictions about future demand.
  - Enables optimization of inventory levels at distribution centers and retail outlets, reducing risk of stockouts or overstocking.
  - IoT can facilitate just-in-time (JIT) inventory management, reducing storage costs and improving overall efficiency.

- **Customer experience and personalization:**
  - Leveraging connected devices and data analytics, manufacturers can gain insights into individual customer preferences, driving habits, and vehicle usage patterns.
  - Data can be used to tailor marketing efforts, personalize product offerings, and provide customized after-sales services, such as maintenance reminders and software updates.
  - IoT can enable manufacturers to implement connected car features, such as remote diagnostics, over-the-air updates, and vehicle tracking.

- **Supply chain visibility and collaboration:**
  - Sharing real-time data on inventory levels, sales performance, and demand forecasts with suppliers, logistics providers, and retailers allows manufacturers to foster better alignment and coordination among supply chain partners.
  - Increased visibility and collaboration can lead to more efficient planning, improved responsiveness to changing market conditions, and enhanced overall supply chain resilience.
  - IoT can enable manufacturers to monitor and evaluate the performance of their supply chain partners, promoting continuous improvement and fostering stronger, more reliable partnerships.

Global Automotive Supply Chain Process Steps Benefiting from IoT Technology – After-sales Support and Service

- **Remote diagnostics and predictive maintenance:**
  - Equipping vehicles with connected sensors and telematics systems, manufacturers can collect real-time data on vehicle performance, component wear, and potential issues.
  - Data can be used to identify and diagnose problems remotely, often before the vehicle owner is even aware of an issue.
  - IoT can enable predictive maintenance, where manufacturers can proactively schedule service appointments based on data-driven insights, minimizing vehicle downtime and improving the overall ownership experience.

- **Over-the-air updates and vehicle customization:**
  - Utilizing connected car technology, manufacturers can remotely deliver software updates, feature enhancements, and performance improvements to vehicles without requiring physical access to the vehicle.
  - Saves time and resources for both manufacturers and vehicle owners but also enables manufacturers to continuously improve and adapt their products to changing customer needs and preferences.
  - IoT can enable manufacturers to offer personalized vehicle customizations and feature upgrades.

- **Enhanced customer support and communication:**
  - By leveraging connected devices and data analytics, manufacturers can gain insights into customer preferences, usage patterns, and service needs, enabling them to offer more personalized and proactive support.
  - For example, IoT can enable manufacturers to send targeted maintenance reminders, service offers, and safety alerts to vehicle owners based on their specific needs and habits.
  - IoT can facilitate more effective communication channels between manufacturers, dealers, and customers, improving the overall customer experience and fostering long-term brand loyalty.

Global Automotive Supply Chain Process Steps Benefiting from IoT Technology – End-of-Life (ELV) Management and Recycling

- **End-of-life vehicle tracking and reporting:**
  - Utilizing connected devices, such as RFID tags and GPS trackers, manufacturers can monitor the location and status of vehicles approaching the end of their life cycle.
  - Data can help manufacturers identify vehicles that are due for recycling or disposal, ensuring compliance with environmental regulations and facilitating efficient end-of-life management.
  - IoT can enable manufacturers to maintain accurate records of end-of-life vehicles, helping meet reporting requirements.

- **Resource recovery and recycling optimization:**
  - Deploying sensors and connected devices at recycling facilities, manufacturers can collect and analyze real-time data on the composition, condition, and value of materials being processed.
  - Data can help optimize recovery of valuable materials, such as metals, plastics, and electronics, from end-of-life vehicles.
  - IoT can facilitate the development of more efficient and environmentally friendly recycling processes, reducing waste, emissions, and energy consumption associated with end-of-life management.

- **Circular economy and sustainable supply chain practices:**
  - Providing real-time visibility into material flows and resource consumption throughout the supply chain, IoT can help manufacturers identify opportunities for waste reduction, resource efficiency, and closed-loop recycling.
  - IoT can enable manufacturers to track and trace the origin, lifecycle, and environmental impact of materials used in their products, allowing them to make more informed decisions about their sourcing and production strategies.
  - IoT can facilitate sharing of data and best practices among supply chain partners, fostering greater collaboration and innovation in the pursuit of sustainability goals.

Recommendations for Driving IoT Adoption for Augmented Supply Chain Logistics

- **Establish a comprehensive National IoT Strategy for Adoption in Supply Chain Management:** The federal government should consider establishing a comprehensive national IoT strategy that outlines clear goals and objectives for IoT adoption in supply chain management. This strategy should encompass regulatory frameworks, infrastructure development, education, and incentives for implementation.

- **Promote creation and adoption of IoT industry standards and protocols:** Industry standards and protocols will help provide assurance of data privacy, security, and reliability, fostering trust among supply chain stakeholders and promoting the exchange of information across the entire ecosystem. This can lead to more efficient, transparent, and resilient supply chain operations, ultimately driving the widespread adoption of IoT technologies in the industry.

- **Establish and provide financial incentives:** Providing incentives aims to encourage businesses to adopt IoT technologies in their supply chain operations by reducing the initial investment costs and perceived risks associated with the implementation of IoT solutions. Financial incentives, such as tax breaks, grants, subsidies, or low-interest loans, can help lower the financial barriers for companies to experiment with and deploy IoT systems.

Recommendations for Driving IoT Adoption for Augmented Supply Chain Logistics

- **Establish and foster public-private partnerships (PPPs) focused on IoT adoption:** PPPs focused on IoT adoption will aim to facilitate collaboration and knowledge sharing between government agencies, businesses, technology providers, and academia. By creating platforms to encourage the exchange of ideas, resources, and expertise, PPPs can help accelerate the development, deployment, and adoption of IoT technologies in supply chain management.

- **Invest in and promote education and workforce development focused on IoT:** By investing in educational programs, training initiatives, and professional development opportunities, the government can help provide assurance that businesses have access to a workforce equipped with the necessary expertise to harness the potential of IoT technologies. This also includes creating partnerships between educational institutions, industry stakeholders, and technology providers to facilitate internships, apprenticeships, and real-world projects that offer practical experience in IoT implementation.

- **Strengthen cybersecurity measures focused on IoT across supply chain networks:** Strengthening cybersecurity measures involves promoting the development and adoption of security best practices, guidelines, and standards specifically tailored to IoT systems in supply chain management. This includes securing data transmission, storage, and access, as well as protecting IoT devices and networks from unauthorized access, manipulation, and cyberattacks.

Recommendations for Driving IoT Adoption for Augmented Supply Chain Logistics

- **Promote international collaboration in IoT adoption across global supply chains:** Promoting international collaboration involves creating platforms and forums where policymakers, industry stakeholders, technology providers, and researchers from different countries can come together to exchange ideas, discuss common challenges, and explore opportunities for joint projects and initiatives. This can lead to the development of harmonized regulations, standards, and guidelines that enable seamless integration of IoT systems across borders, fostering efficient and resilient global supply chain networks.

- **Support and strengthen sustainable and scalable growth in the domestic IoT manufacturing supply chain:** This is achieved via an appropriate mix of policies, incentives, and grants that can gradually phase in domestic content requirements allowing manufacturers to effectively meet deployment goals and strive towards a future where this content Is Made in All of America by All of America's Workers.

Sub Working Group Outline on
Smart Supply Chain Traceability

Significance - IoT Markets Fueled by Electronics Value Chains

IoT Markets ($Billion)	2021	2030	CAGR %	Markets, Uses and Applications	IoT Systems & Devices	Top System OEMs	Top Chip Suppliers (Supply Chain Provenance)
Industrial	**326.1**	**1742.8**	**20.5%**	Manufacturing, Energy & Power, Oil & Gas, Smart & Critical Infrastructure, Logistics & Transport, Agriculture	DCS, PLCs, SCADA, UPS, Systems (Remote Monitoring, Control , Intrusion Detection)	IBM, Siemens, Cisco, GE, Schneider, Rockwell, PTC, Microsoft, SAP, Honeywell	TI, Infineon, ADI, ST, Renesas, NXP, Maxim, Microchip, ON Semi, Micron, GF, TSMC
Manufacturing	**205.8**	**1523.9**	**24.9%**	PROCESS: Energy, Utilities, Chemical, Food & Bev, Water/Waste; DISCRETE - Automotive, Machine, Electronics	PLCs, HMIs, IPCs, Process Sensors, SCADA, Drives, RFID	Siemens, ABB, Honeywell, Emerson, Schneider, MEL, GE, Rockwell, Bosch	Intel, Advantech, Kontron, NXP, TI, Infineon, ADI, ST, NVIDIA, Renesas, GF, TSMC
Automotive	**82.7**	**621.8**	**25.1%**	Fleet Management, V2V Comms, Vehicle to infrastructure, Navigation, Infotainment, Telematics, Autonomy	ECUs, CAMs, ABS, ADAS, Infotainment, Telematics, etc.	Toyota, VW, Hundai, GM,Ford, Honda, Nissan, BMW, Daimler, KIA, Audi, Tesla, etc.	NXP, Infineon, TI, ST, Renesas, ADI, ON Semi, Qualcomm, Intel, Micron, GF, TSMC
Consumer	**221.7**	**616.7**	**12.0%**	Wired, Wireless Connectivity; Consumer Electronics, Healthcare, Wearables, Automotive Gadgets	Smart Home - thermostats, locks, lighting, appliances, motion sensors, irrigation, etc.	Amazon, Google, Samsung, LG, Xiaomi, Philips, Nest Labs, Bosch, Whirlpool, Electrolux	Qualcomm, MediaTek, NXP, TI, Broadcom, Samsung, Intel, ST, Infineon, Micron, TSMC
Transportation	**85.2**	**498.5**	**21.7%**	Road/Rail/Airways, Maritime; Traffic Control, Telematics, Security & Surveillance , Remote Monitoring	Automtotive, GPS, Systems for Control, Diagnostics, Traffic, Collision Avoidance, etc.	Bosch, Continental, Denso, Magna, Valeo, Aptiv, ABB, Siemens, Cisco, Schneider	NXP, Infineon, TI, ST, Renesas, ADI, ON Semi, Micron, Maxim, Intel, GF, TSMC
Aerospace & Defence	**42.4**	**156.3**	**15.6%**	Fleet Management, Equipment Maintenance, Security, Space Systems, Air/Sea/Ground Vehicles	Systems - Radar, Sonar, Flight Control, Avionics, Missile guidance, Satellites, etc.	Boeing, Airbus, Lockheed Martin, Northrop Grumman, Raytheon, BAE Systems, etc.	Intel, ADI, Xilinx, TI, ST, NXP, Infineon, Microchip, ON Semi, GF, Maxim, Micron, TSMC

*Source: https://www.precedenceresearch.com/

Opportunities and Drivers for Traceable IoT Value Chains

- **Increased demand for IoT devices:** The Covid-19 pandemic has led to an increased demand for connected devices, particularly in areas such as healthcare, remote monitoring, and smart homes. This has created new opportunities for chip and electronic device manufacturers to supply these devices and related components.

- **Accelerated digital transformation:** The pandemic has accelerated the digital transformation of many industries, leading to a greater need for IoT devices to support remote work, e-commerce, and other digital applications. This has fueled demand for electronics used for IoT devices and chips parts manufactured in various sources of origin.

- **Reshoring and diversification of supply chains:** Shortages have highlighted the risks associated with overreliance on a single supplier or region for critical components. This has led many companies to re-shore or diversify their supply chains, creating new opportunities for electronics manufacturers to expand their customer base.

- **Geopolitical tensions, restrictions, sanctions:** Geopolitical tensions have led to trade restrictions and tariffs, making it more difficult for companies to source components from certain regions. This drives new opportunities for OEMs to supply trusted devices and components that establish market preference and regulate market access and usage.

- **Global cybersecurity and supply chain drivers:** EO 14017 for supply chain security, plus the recent enacted NDAA laws on supply chain traceability plus the national cybersecurity strategy, call for increased cooperation with international allies to address supply chain risks thought transparency, risk management and intelligence sharing.

Opportunities and Drivers for Traceable IoT Value Chains

- **Establish Provenance during design and manufacturing:** Supply chain attacks have become increasingly common, and cybercriminals often target supply chains as a way to gain access to sensitive data or systems. By implementing supply chain provenance and traceability linked to design and manufacturing supply chain risks can be reduced.

- **Ensuring the security and integrity of critical systems:** Many systems in critical infrastructure and transportation, rely on hardware and software components from many suppliers. Supply chain traceability can ensure the security and integrity of these systems by tracking the origin and path of every component (HBOM, SBOM, DBOM).

- **Leveraging the IoT Cybersecurity labeling program to drive new requirements**: The Consumer IoT Cybersecurity labeling can be an effective way to raise awareness and drive supply chain traceability requirements and standards for the components used in IoT devices. The labeling infrastructure can be leveraged for other IoT markets.

- **Strengthening international cooperation for provenance:** The recent announcement between the US & EU to coordinate on CHIPS Acts subsidies, provides opportunities to share information on manufacturing provenance and collaborate on strategies to manage supply chain traceability that will help mitigate vulnerabilities and risks.

- **Addressing the growing threat of nation-state cyber attacks:** Nation-state cyber attacks are growing as attackers target's systems or data, while remaining undetected and difficult to defend. Upstream supply chain traceability (from SBOM to underlying HBOM) can help trace such attacks and improve the ability to manage vulnerabilities.

Opportunities to Create Digitalized IoT Value Chains

- **Chip Design, Manufacturing and Delivery:** Internal workflow traceability of IC design, manufacturing, assembly, and test. External asset traceability (via distributor) of chip delivery to ODMs, OEMs, and/or contract manufacturers.
- **PCB Design and Assembly:** Internal workflow traceability of PCB design and provenance of Bill of Materials (BoM) for PCB/System Assembly. External asset traceability of device delivery to OEMs and integrators.
- **Embedded System Delivery:** Internal workflow traceability of embedded system, OS, and software and external traceability of device/system delivered, at end-customer site, attested and securely onboarded to the cloud.
- **Device Lifecycle Management:** External (in-field) traceability of connected device, hardware upgrades, software updates, internal status, real time application data, and internal traceability of (AI-based) applications and services.
- **Application Lifecycle Management:** Internal & external traceability of software development workflows including SBOM, integrity, and software supply chain delivery, plus traceability of the data produced by edge apps.
- **Recycling or Decommissioning:** Internal & external traceability "catch all" of hardware for any markets. Recycled components must be reset to manufacturers defaults and EOL components must be flagged as retired.

Opportunities to Create Trusted Enterprise Traceability

- **Digitalization of Workflows with Metadata Indexing** for provenance of workflows including inputs, tasks, outputs, and deliverables among people, tools, and machines without compromising users' proprietary data.
- **Cryptographic Traceability and Hand-offs** including public-private ledgers of metadata indices with permissioned access for visibility and assurance of provenance data and that workflows were not tampered or altered.
- **Asset Identifiers and Certificates** for workflows producing physical assets* (such as Wafers, Dies, Chips, PCBs, Systems), used for provenance of product, authentication, and attestation in the supply chain and during field use.
- **Digitalized Market Access** whereby asset deliverables are tied to standards for monetization, enablement of scalable business models, new services, and data-driven revenue streams.
- **Secure Connectivity Protocols** across hardware, firmware, OS, Edge, cloud and smart infrastructure driven by devices Root of Trust based provisioning, onboarding, monitoring, reporting and updates.
- **Authentication and Attestation linked to Cybersecurity labels** to establish a digital paper trail and ensure that products do not contain counterfeit parts, that they are trusted and that they function as originally intended.

*These are asset types for the electronics & semiconductor supply chains. For other supply chains, replace them with other assets.

Recommendations to the Federal Government

- **Encourage the use of Global Identifier Standards for supply chain traceability:** The federal government should collaborate with international allies to create programs that incentivize suppliers to establish unique corporate IDs, product IDs, asset IDs and part IDs by using global standards such as GS1. By using Identifiers to track & trace any assets from design to manufacturing to field use, this will help enhance national security, protect public health and safety, promote environmental sustainability, and meet consumer demand for transparency and accountability.

- **Promote development and use of trusted architectures for supply chain provenance and traceability:** The federal government should incentivize hardware suppliers to develop trusted architectures for supply chain provenance and traceability. By cryptographically linking the SBOM to trusted HBOM, industries can help mitigate the risks associated with compromised components and ensure the security of critical systems. This will provide benefits for national security, public safety, and economic stability, making it a worthwhile investment for the government and society.

- **Accelerate creation of a trusted digital thread (DBOM) in the value chain:** The government should support the development of a digital thread or DBOM by incentivizing companies to digitalize their workflows and leverage the Cybersecurity labeling program to create a digital trail of IoT systems' holistic Bills of Materials (DBOM, HBOM, SBOM) that vary by vertical market. The creation of a *Trusted* digital thread will enable marketplaces of data producers and data consumers that can have a significant impact on supply chain traceability, innovation, efficiency, security and economic growth.

Recommendations to the Federal Government

- **Encourage global cooperation on supply chain traceability standards:** NIST and the wider USG should work with international partners to integrate the Cyber Security Framework (CSF) with IoT Security and Cyber-Supply Chain Risk Management (C-SCRM) to enable digitalization methodologies and consistent traceability metrics across borders. This will help reduce compliance costs, track goods across the globe, improve customs controls, reduce administrative burdens, improve global trade and ensure that supply chains are transparent, efficient, and resilient.

- **Incentivize the OT Supply Chain to accelerate adoption of trusted traceability.** Ensuring the security and integrity of the OT supply chain is essential to accelerate IT/OT convergence and prevent cyber-attacks in critical infrastructure that could result in serious human and economic losses. To incentivize the adoption of trusted traceability methods for the OT supply chain, the government could offer tax credits, grants, or other financial incentives to companies that offer traceable OT products. The government could also require contractors and suppliers to adhere to specific security and traceability standards when bidding on government contracts especially for critical infrastructure.

- **Promote the Creation of Trusted IoT Network Ecosystems:** Drive awareness and interoperability programs on how trust is established among devices, networks, and personas operating in connected IoT environments, in ways that enable secure and reliable data exchanges and protect against malicious attacks, data breaches, and other security threats. By promoting a framework of trust, the government can have a significant impact on the security and resilience of critical infrastructure, information sharing, innovation, data protection, international cooperation and international trade.

Recommendations to the Federal Government

- **Incentivize formation of trusted data marketplace:** The government can incentivize marketplaces where data producers and consumers can connect and share data, enabling better supply chain visibility and traceability. This can drive incentives for market preference, regulated access & use of goods as well as tax credits or subsidies. This will help producers and consumers reduce costs, improve efficiency by streamlining processes and eliminate redundancies, especially in complex supply chains where information flows are often fragmented or disconnected.

- **Subsidize digitalization of enterprises in the IoT value chain:** The digitalization of all business functions (design, production, marketing, procurement, distribution, etc.) enables more efficient management, greater visibility and traceability over supply chains to track products, monitor quality, and fix issues or defects. By using cryptographic methods, digitalization can have a major impart in the security, reliability, and integrity of the data for the digital economy. By providing incentives for businesses to adopt digital technologies and tools, the federal government can help promote secure ecosystems, and economic growth while creating opportunities for businesses and workers.

- **Promote creation of trusted value chains:** Promote orchestration of networks of entities, such as manufacturers, service providers, and regulatory bodies, that interact to establish and maintain Trust through collaboration and accountability to ensure that the IoT value chains and infrastructure are secure, transparent, trustworthy. By providing incentives for businesses to adopt transparent workflow practices, the federal government can help drive economic growth and social responsibility while protecting against supply chain vulnerabilities and risks.

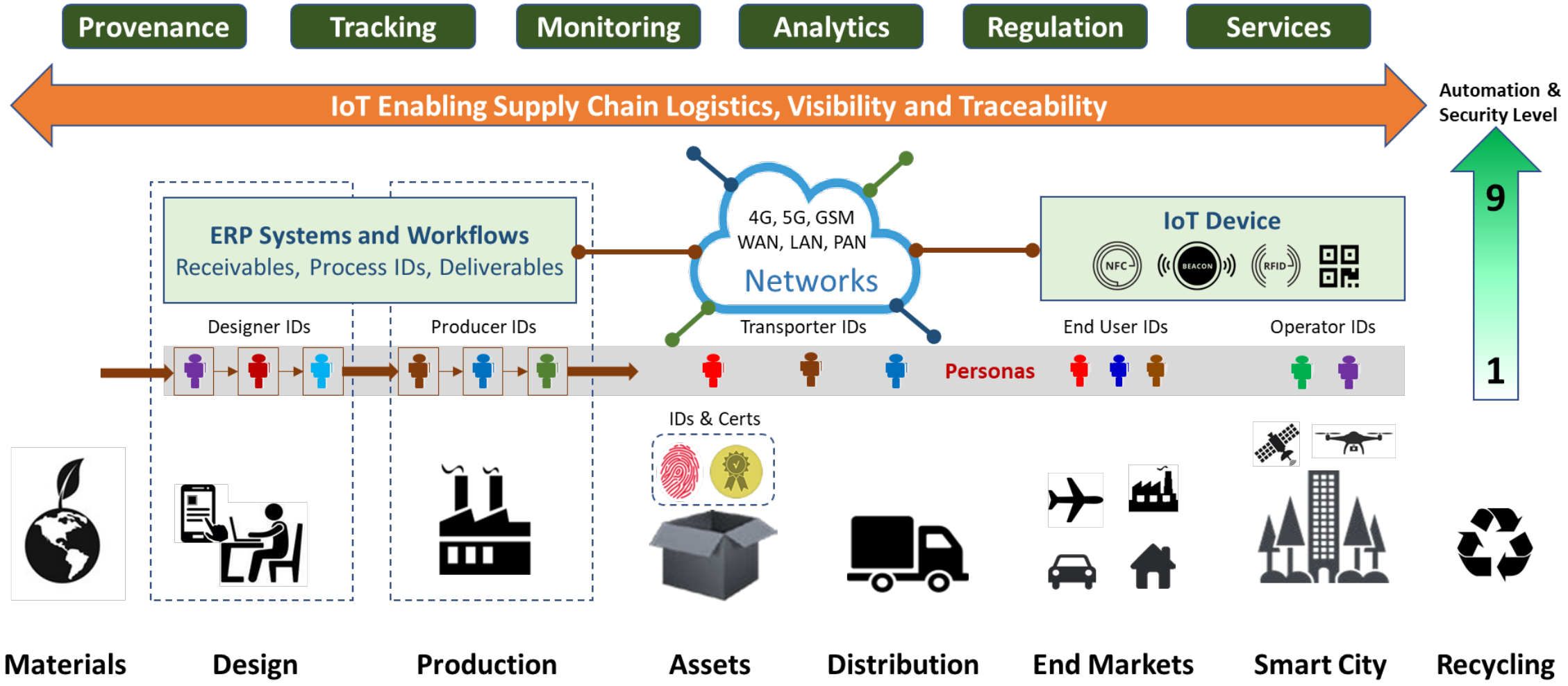
Recommendations to the Federal Government

- **Subsidize orchestrated value chain partnerships:** The federal government can accelerate the creation of traceable supply chains by subsidizing orchestration of connected Private-Public Partnerships across complex value chains that digitalize portions of supply chains piecemeal using consistent methods of “receivables-process-deliverables”. This can help supply chain stakeholders to collaborate in parallel and accelerate adoption of traceability and be more efficient which will help businesses to drive economic growth while developing resilient and secure supply chains.

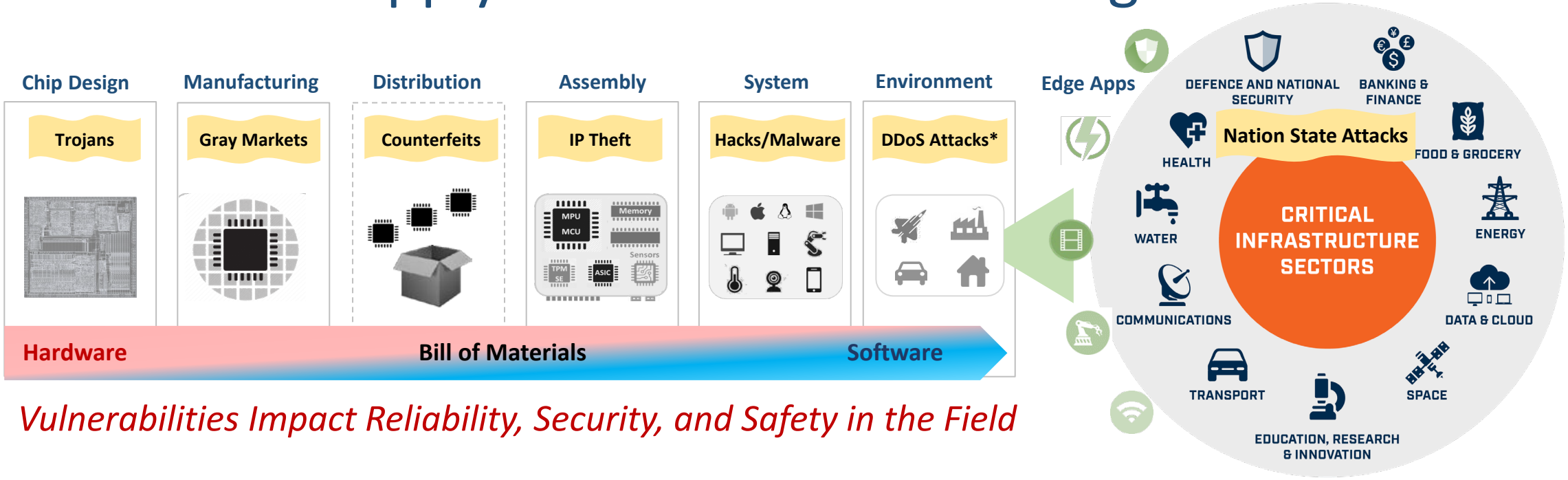
- **Establish Data policies that drive economic growth:** Monetization of data will require infrastructure for Security & Privacy, Data Sharing, Ownership and Control Frameworks, Identity and Access management (IAM), Data Protection, Sharing and Exchange, plus Data Analytics with AI to minimize supply chain risk and maximize economic value. Policies related to data can have a major impact on privacy, security, interoperability, transparency, accountability, innovation, and monetization, as it can fuel synergistic ecosystems and the future digital economies.

- **Facilitate the Creation of Data-driven business ecosystems:** The federal government should raise awareness about the *New Gold*, Data Monetization Strategies, Data Analytics for Insights, Trusted Data Marketplaces, Platform-based Business Ecosystems, Network effects, Digital Thread of Data in connected value chains, Data Regulations, and tools for Monitoring and Managing Data Marketplaces. Data-driven networks of interconnected businesses, technologies, and platforms can leverage synergies to create new revenue streams and enhance existing products and services.

Scope – Any Supply Chain Logistics & Traceability



Electronics Supply Chain Risks and IoT Edge Vulnerabilities



Vulnerabilities Impact Reliability, Security, and Safety in the Field

- Disaggregated electronics supply chain
- Over 65% of electronics assembled in Asia
- Ineffective sanctions and Customs controls
- **Costly support, liabilities, loss of value**

- No policy* for IIoT Systems & Process Sensors
- Silos and no visibility in IT/OT connectivity
- Limited real time visibility & control of security
- **Compromised equipment and human safety**

Lack of supply chain traceability threatens national security and economic prosperity