



Delay/Disruption Tolerant Networking (DTN) Recommendations Overview

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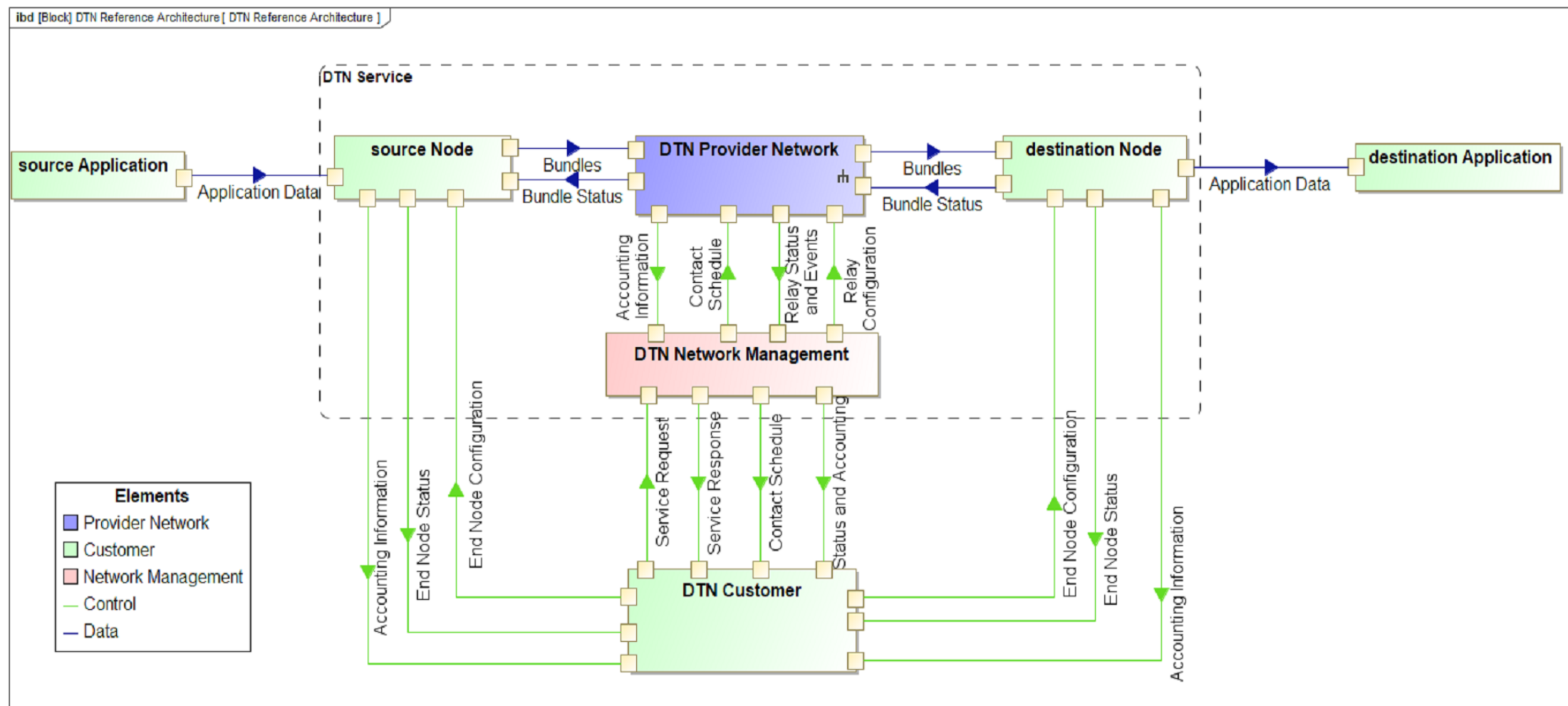
- GSFC DTN Project is developing a Bundle Protocol version 7 (BPv7) compliant generic DTN node that can be infused with missions and providers
 - Node can be software only or software with hardware acceleration (using FPGAs)
 - Node can act as a source, destination or relay node
 - Primarily focused on flight implementation. Can be used on ground also
- Uses:
 - NASA Class B and A design patterns
 - Policy and constraints
 - Security principles
 - Spacecraft operability principles
- Intend to make software available with open-source (Apache 2.0) license and products to enable infusion
- Conforms with LunaNet Interoperability Specification

- Nominal engineering processes have been tailored to address the design of a generic DTN Capability versus a specific system
- Foundation information has been extracted from NASA Handbooks/NPRs, DTN Standards, and SSI Operations Concepts
 - Following NPR 7123.1D processes for SE processes
 - Following NPR 7150.2D processes for Class B software development
 - Certifiable to Class A/B
- A set of DTN Services have been formulated to anchor a Customer aware engineering strategy
- System engineering using Model Based System Engineering (MBSE) approach

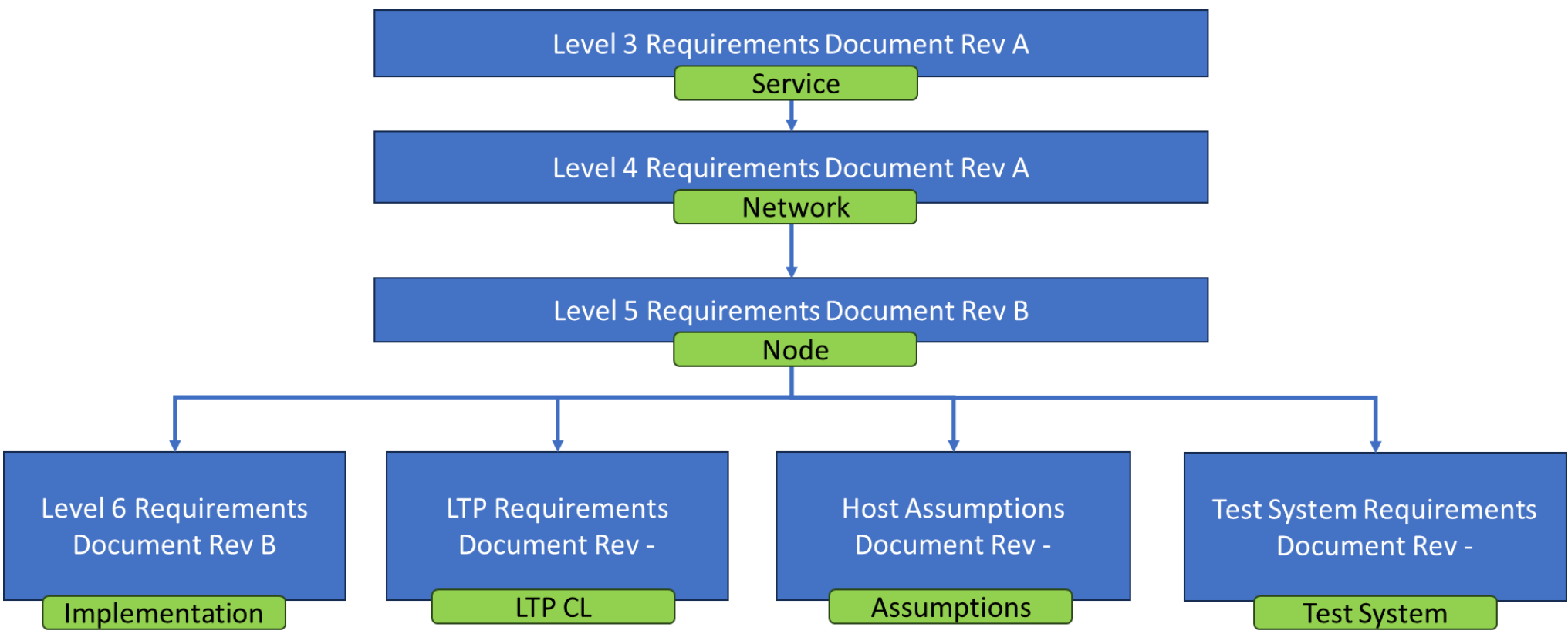


- GSFC DTN Project developed Level 3 (service), Level 4 (network), Level 5 (node), Level 6 (implementation) recommendations to inform the design and implementation of DTN products
- Recommendations are based on standards, LunaNet Interoperability Specification, and best practices
- A DTN Reference Architecture was developed as the foundation for deriving nominal system level operational scenarios and requirements
 - Covers end to end data flows between customer platforms and facilities
 - Enables differentiation between data plane and control plane functions
 - Allows the interaction between a DTN Provider Network of Relay Nodes and the DTN Network Management subsystem

DTN Reference Architecture



- Developed L3 (service), L4 (network), L5 (node), L6 (implementation) requirements to inform the design and implementation of DTN products



- End user and network operational recommendations for a DTN Service implementation
- Grouped into End User Services and Network Operational Services
 - **End User Services:**
 - Services a user can request in a Service Level Agreement (SLA)
 - Selections affect the Quality of Service (QoS)
 - **Network Operational Services:**
 - Services provided by DTN Network Management
 - Needed to configure, instantiate, and orchestrate the end-to-end service network to achieve user requested service levels
 - Entities providing Network Operational Services may also use the End User Services

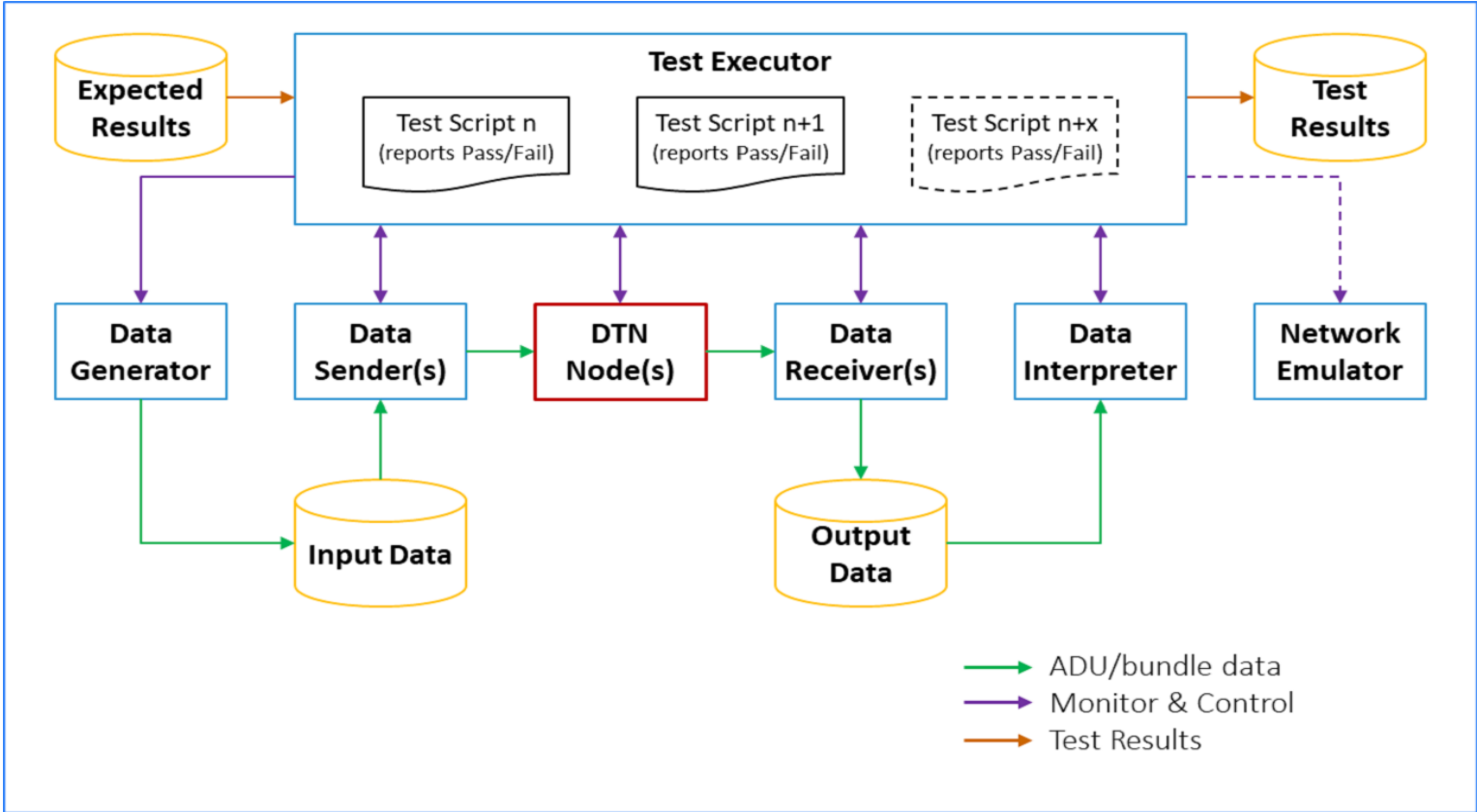
End User Services		Network Operational Services	
Data Transport Services	DTN.3.00020 - Retention Assurance	Control Cycle Management	DTN.3.00140 - Service Configuration Generation
	DTN.3.00010 - Data Delivery Reliability		DTN.3.00150 - Service Configuration Distribution
	DTN.3.00040 - Latency		DTN.3.00130 - Service Monitoring
	DTN.3.00080 - Data Confidentiality		DTN.3.00190 - Service Management
	DTN.3.00180 - Data Integrity		
	DTN.3.00090 - Data Authentication	Resource Management	DTN.3.00030 - Transport Management
	DTN.3.00160 - Application Interface		DTN.3.00050 - Storage Management
	DTN.3.00070 - User Data Accounting		
	DTN.3.00100 - User Defined Extension Blocks		
	DTN.3.00060 - Payload Sizing		
Emergency Services	DTN.3.00120 - Emergency Service		

- DTN Network-level requirements based on DTN Reference Architecture
- Respond to Level 3 Service recommendations
- Recommendations grouped into
 - End Node
 - Destination End Node
 - Source End Node
 - Provider Network
 - Network Management
- Include security, QoS, emergency and safe mode, BIBE, and first hop last hop recommendations

- Recommendations for a generic DTN node which can act as a:
 - Source Node
 - Relay (intermediate) Node
 - Destination Node
 - Edge Node
- Respond to Level 4 Network requirements
- Grouped into functional areas:
 - BSR Generate and Store
 - Bundle Create and Store
 - Bundle Fragmentation
 - Bundle Ingest, Validate, and Store
 - Bundle Payload Delivery
 - Bundle Reassembly
 - Bundle Routing and Egress
 - Bundle Storage and Management
 - CBR Generate and Store
 - Command Execution
 - Custody Signal Generation and Receipt
 - Monitor and Control
 - Node Health and Safety
 - Security
 - Telemetry and Event Reporting

- Implementation recommendations for a generic DTN Node
- Includes:
 - Requirements from IETF RFCs, CCSDS Blue Books
 - Requirements for Management Information Base (MIB) parameters
 - Requirements to handle faults and unexpected inputs
- Grouped into Modules
 - Admin Statistics
 - Node Configuration
 - Framework Proxy
 - CLA
 - Contact Schedule
 - CBOR
 - Time Management
 - Administrative Record Processor
 - Bundle Interface
 - Storage
 - Custody Transfer
 - Extension Block Processor
 - Payload Interface
 - Event Management
 - Fragmentation
 - Policy Database
 - Job Scheduler
 - Memory Allocator
 - Performance Logger

- Added new Test System Recommendations Document
- Specifies recommendations for a system to test a generic DTN Node
- Based on Test Framework shown to the right



- **Host Assumptions:**

- Assumptions for a generic DTN Node based on expectations of capabilities the host will provide and the DTN Node does not need to implement
 - Host is the platform the DTN Node runs on and interacts with
- Capabilities of the host will not be included as recommendations at Level 6

- **LTP recommendations:**

- Includes recommendations for an LTP Convergence Layer (CL) which will interface with a generic DTN Node Convergence Layer Adapter (CLA)
- Convergence Layers have been separated out of the main Level 6 requirements set

- Latest versions updated for the GSFC CDR-Level Design Review
- Planned deferrals coming for future releases
 - Additional CL requirements documents (mostly focused on options and setup needed to interface with the CLs for existing CLs)
 - Updates to protocols as CCSDS books are updated
 - Node Self-Test (Level 6)
 - BPsec (Confidentiality/Authentication/Integrity)
 - Light Weight Transfer Protocol (LWTP)
 - Relay Fragmentation
 - Network Management Interface updates, Policy Definition and Instantiation
 - Multipoint
 - QoS
 - Bundle in Bundle Encapsulation
 - First hop/Last hop
 - Emergency Services
- Working to release recommendations documents to the DTN community
 - Comments welcome!



Backup

- **End User Services:**
 - ***Data Transport Services:***

Requirement #	Service	Summary
DTN.3.00020	Retention Assurance	Basic service with different levels of data retention assurance, such as no retention, best effort, acknowledged retention
DTN.3.00010	Reliability	Provides different levels of reliability for data delivery such as bundle Custody Transfer, LTP and TCP exist at different layers
DTN.3.00040	Latency	Allows specification for different levels of latency, such as lower latency for telemetry streaming or higher latency for science data.
DTN.3.00080	Data Confidentiality	Establishes a process for providing data confidentiality as data passes between security domains and through Provider Networks.
DTN.3.00180	Data Integrity	Ensures that changes to target data within a bundle can be discovered.
DTN.3.00090	Data Authentication	Security mechanisms that protect the infrastructure from unauthorized use. Data includes end user data and other data in various extension blocks.
DTN.3.00160	Application Interface	Provides LWTP services such as Ordered Delivery (In-order with gaps), Ordered Delivery with backfill (In-order with less gaps), Sequence Delivery (In-order without gaps based on best effort), Gap Detection, and Duplicate Suppression.
DTN.3.00070	User Data Accounting	Allows end user to monitor SLA compliance
DTN.3.00100	User Defined Extension Blocks	Allows end users to specify custom extensions blocks, where custom extensions block is not a standardized extension block.
DTN.3.00060	Payload Sizing	User Application PDUs may be small or too large to make optimal use of the DTN Service and would benefit from aggregating/concatenating multiple user datagrams into a single ADU. Can also inhibit bundle fragmentation.

- **End User Services:**
 - *Emergency Service:*

Requirement #	Service	Summary
DTN.3.00120	Emergency Service	Request the establishment of a communication path to source nodes without going through the normal scheduling process to respond to emergency situations.

- **Network Operational Services:**

Requirement #	Service	Summary
DTN.3.00140	Service Configuration Generation	Generate individual node and/or service provider configurations to enable service operations using information from the Transport, Storage, and Service Management functions
DTN.3.00150	Service Configuration Distribution	Distribution of generated configurations to DTN nodes and/or node operations centers
DTN.3.00130	Service Monitoring	Gathering service-related parameters from DTN nodes and/or node operations centers
DTN.3.00190	Service Management	Gathers and processes node storage information, both current and predictive as input to Service Configuration Generation
DTN.3.00030	Transport Management	Gathers and processes node network topology, contact information, available CLs, and SLA information to determine QoS configuration as input to Service Configuration Generation
DTN.3.00050	Storage Management	Gathers and processes node storage information, both current and predictive as input to Service Configuration Generation