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Future Communications Needs (5 years unless otherwise noted)

Functional Requirements (See Definitions Below) — Quantified Estimates
Technology Options for Each Network Tier - Top Three Choices (1 = first, 2 = second, 3 = third)

Tier column groups: Tier 1 – Core | Tier 2 – Backhaul | Tier 3A – Access (to end-points or collectors/gateways/take-out-points (if present)) | Tier 3B (collectors to endpoints) | Tier 4 – HAN

Category	Sub	Application	Est # Comm Nodes	Est # End Point Devices	AC Indep (hrs)	BW/Node (kbps)	Coverage (%)	Latency (msec)	Reliability (%)	Security	T1 Lic Wireless MW (pt-pt)	T1 Fiber	T1 Other Priv (BPL,PLC)	T1 Comm Wireless (wireline)	T1 Sat	T2 Lic Wireless MW (pt-pt)	T2 Fiber	T2 Other Priv (BPL,PLC)	T2 Comm Wireless (Cellular)	T2 Comm Wireline	T2 Sat	T3A Lic Radio (pt-multipt)	T3A Lic Wireless MW (pt-pt)	T3A Fiber	T3A Other Priv (BPL,PLC)	T3A Comm Wireless (Cellular)	T3A Comm Wireline	T3A Sat	T3B Unlic Wireless (RF Mesh)	T4 Unlic Zigbee	T4 Other Priv HomePlug
Customer	Advanced Metering	Remote Meter Reading (based on hourly reads)	500	3,500,000	0	106	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1	1	2
Customer	Advanced Metering	Direct Load Control	500	3,500,000	0	106	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1	1	2
Customer	Advanced Metering	Outage reporting & voltage sensing	500	3,500,000	0	106	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1	1	2
Customer	Advanced Metering	Real time pricing	500	3,500,000	0	106	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1	1	2
Customer		Distributed Generation Management	1,750 (Residential DG nodes)	1,750 (Residential DG nodes)	0	9.6	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1	1	2
Customer	PEV Integration	At the customer premises	500	TBD	0	106	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1	1	2
Customer	PEV Integration	At charging stations	500	TBD	0	106	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1	1	2
Customer		Pricing Signals to Smart Appliances	500	3,500,000	0	106	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1	1	2
Customer		in-Home Display of Customer Usage	500	3,500,000	0	106	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1	1	2
Distribution		Automated Feeder Switching	NA	900	24	56	95%	200	99.990%	5	2	1			3	2	1				3	2				3	1				
Distribution		Individual Feeder Switches	NA	725	24	56	95%	200	99.990%	5	2	1			3	2	1				3	2				3	1				
Distribution		Capacitor Bank Control	500	4,500	0	9.6	95%	2000	99.000%	3	2	1			3	2	1				3		2			1		3	1		
Distribution		Fault Current Indicator	500	1,125	0	9.6	95%	2000	99.000%	3	2	1			3	2	1				3		2			1		3	1		
Distribution		Transformer Monitoring (via smart meters)	500	3,500,000	0	56	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1		
Distribution		Voltage and Current Monitoring (via smart meters)	500	3,500,000	0	56	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1		
Distribution		Renewable Energy/Distributed Generation	125 C&I (Growing at ~5/year)	125 C&I (Growing at ~5/year)	24	56	100%	200	99.990%	5	2	1			3	2	1				3	3	2			1					
Distribution		Network Protection Monitoring (via smart meters)	500	3,500,000	0	56	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1		
Distribution		Street Light Monitoring/Control	50	10,000	0	19.2	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1		
Operations		AMI Network Management	500	3,500,000	0	106	100%	2000	99.000%	5	2	1			3	2	1		3				2			1		3	1		
Operations		Remote Connect/Disconnect	500	3,500,000	0	106	100%	2000	99.000%	5	2	1			3	2	1		3				2			1		3	1		
Operations		Meter Data Management	500	3,500,000	0	106	100%	2000	99.000%	5	2	1			3	2	1		3				2			1		3	1		
Operations		Outage Management	500	3,500,000	0	106	100%	2000	99.000%	5	2	1			3	2	1		3				2			1		3	1		
Operations		Distribution Asset Management	500	800,000	0	106	100%	2000	99.000%	5	2	1			3	2	1		3				2			1		3	1		
Operations		Distribution Underground Network Management	NA	210	24	106	1%	200	99.990%	5	2	1	3			2	1			3						1	3	2				
Operations		Demand Response	500	3,500,000	0	106	100%	2000	99.000%	5	2	1			3	2	1		3				2			1		3	1	1	2
Transmission		Field Substations & Switching Stations	NA	1,150	24	1,500	100%	200	99.999%	5	2	1			3	2	1				3	2	1					3			
Transmission		Wide Area Situational Awareness (PMUs)	NA	50	24	1,500	100%	20	99.999%	5	2	1			3	2	1				3	2	1					3			
Transmission		Line Protection and Control	NA	1,150	24	1,500	100%	200	99.999%	5	2	1			3	2	1				3	2	1					3			
Transmission		Mobile Substation/Equipment	NA	25	24	56	100%	200	99.990%	5	2	1			3	2	1				3	3	2			1					
Transmission		System Protection/Teleprotection	NA	550	24	9.6	100%	20	99.9999%	5	3	1	2			3	1	2					3	1	2							
Service Provider		Billing (via smart meters)	500	3,500,000	0	106	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1	1	2
Service Provider		Customer Information Management (via smart meters)	500	3,500,000	0	106	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1	1	2
Service Provider		Consumer Web Portal (via smart meters)	100 retailers	3,500,000	0	106	100%	2000	99.000%	5	2	1			3	2	1				3		2			1		3	1	1	2
Other		Emergency Response	NA	3,000	72	45	100%	500	99.990%	3	2	1	3			1	2			3		1				3		2			
Other		Routine Dispatch	NA	3,000	72	45	100%	500	99.990%	3	2	1	3			1	2			3		1				3		2			
Other		Work Management	NA	2,050	8	256	90%	5000	99.900%	3	2	1			3	2	1	3					2			1		3			
Other		Black Start Operations	NA	300	168	15	100%	2000	99.999%	3	3	2			1	3	2				1		2					1			

Customer:

Advanced Metering - 106 kbps per collector (.00888 kbps per meter) with 12000 meters per collector (dense urban) dropping to 100's per collector (rural) with mature HAN communications

Distributed Generation Management - Oncor will have ~1750 residential customers with renewable energy sources (wind and solar) and is growing by ~250/year which will be managed by advanced meters with internal disconnect switches and AMIS/HAN communications.

PEV Integration - Potential data traffic is included in Advanced Metering traffic estimates and delivered by HAN (i.e. Zigbee or HomePlug)

Pricing Signals to Smart Appliances - Potential data traffic is included in Advanced Metering traffic estimates and delivered by HAN (i.e. Zigbee or HomePlug)

In-home Displays of Customer Usage - Potential data traffic is included in Advanced Metering traffic estimates and delivered by HAN (i.e. Zigbee or HomePlug)

Distribution:

Automated Feeder Switching - Oncor has ~900 fully automated switches organized into "teams" with distributed intelligence for automated outage restoration, growing by ~75 per year.

Individual Feeder Switches - Oncor has ~725 remotely controlled switches (by D-SCADA), growing by ~50 per year.

Capacitor Bank Controls - Oncor will have ~4500 remotely controlled capacitor banks via one-way paging communications currently, but is planning to migrate to using the Advanced Metering communications infrastructure to enable full two-way communications over the next five years to all capacitors located within the advanced metering communications area, potential traffic is included in Advanced Metering traffic estimates above

Fault Current Indicators - Oncor is planning to use the Advanced Metering system communications infrastructure to deliver the fault current sensor values to the appropriate head-end application, potential traffic is included in Advanced Metering traffic estimates above

Transformer Monitoring - Oncor is planning to use the Advanced Metering system to sense end-point voltage values and report outages via the "last gasp" functionality of the meters to monitor transformers. Oncor will use t infrastructure to deliver these values to the appropriate head-end application, potential traffic is included in Advanced Metering traffic estimates above.

Distribution (continued):

Voltage & Current Monitoring - Oncor is planning to use the Advanced Metering system to sense end-point voltage values and use the advanced metering communications infrastructure to deliver these values to the appropriate head-end application, potential traffic is included in Advanced Metering traffic estimates above

Renewable Energy/Distributed Generation - Oncor has ~125 C&I customers with conventional fuels (diesel, natural gas, landfill/sewage gas) or renewable energy sources (wind, solar) and is growing by ~5/year which will be managed by direct communications to local SCADA-like RTUs and external disconnect switches.

Network Protection Monitoring - Oncor is planning to use the Advanced Metering system to sense end-point voltage values and report outages via the "last gasp" functionality of the meters to monitor network protection. Oncor will use the advanced metering communications infrastructure to deliver these values to the appropriate head-end application, potential traffic is included in Advanced Metering traffic estimates above.

Street light Monitoring/Control - Street light monitoring uses similar architecture to Advanced Metering with individual gateways acting as take-out-points for communications to/from up to 5000 lights each, lights to gateway

Operations:

AMI Network Management - **Potential** data traffic is included in Advanced Metering traffic estimates above

Remote Connect/Disconnect - **Potential** data traffic is included in Advanced Metering traffic estimates above

Meter Data Management - **Potential** data traffic is included in Advanced Metering traffic estimates above

Outage Management - **Potential** data traffic is included in Advanced Metering traffic estimates above and based upon "last gasp" reporting from smart meters to collectors (with battery backup)

Distribution Asset Management - Monitoring of distribution equipment (inc. transformers, fault indicators, etc.) potential data traffic is included in Advanced Metering traffic estimates above and based upon reporting by exception when conditions exist outside "normal" parameters

Distribution Underground Network Management - Monitoring and control of equipment located in underground vaults and manholes in downtown distribution network grids

Demand Response - **Potential** data traffic is included in Advanced Metering traffic estimates and delivered by HAN (i.e. Zigbee or Homeplug) to customers' controllable devices

Transmission:

Field Substations & Switching Stations - Broadband service required to field stations to support multiple VLANS (T-SCADA, D-SCADA, AMIS, enterprise, and other communications) whereby data from various event recorders and equipment condition monitoring devices output data streams will be carried to head-end systems with the appropriate priority of service (QoS)

Wide Area Situational Awareness (PMUs) - Units co-located with a limited number of field stations at key physical/electrical locations on the grid and data is transported with other station data streams within the appropriate VLAN

Line Protection and Control - Equipment is co-located with field stations and data is transported with other station data streams within the appropriate VLAN

Mobile Substation / Equipment - Communications to mobile equipment limited to SCADA activities to monitor and control equipment

System Protection / Teleprotection - Teleprotection communicates from switching station to switching station on either end of transmission lines to coordinate breaker control for enhanced line protection and coordination

Service Provider:

Billing - Billing information will be gathered by the Advanced Metering system and potential data traffic is included in Advanced Metering traffic estimates above

Customer Information Management - Customer information will be gathered and managed by the Advanced Metering system and potential data traffic is included in Advanced Metering traffic estimates above

Consumer Web Portal - All consumer information for the Web Portal will be gathered and managed by the Advanced Metering system and potential data traffic is included in Advanced Metering traffic estimates above, note that an estimated 100 retail electric service providers will sell energy to all 3.5 million advanced metered premises in the Oncor service area in about 5 years

Other:

Emergency Response - Mobile voice communications with VoIP codex of 15 kbps per channel, inclusive of control communications, with three channels in PTT mode per basestation, mobile data limited to ~200 kbps maximum (110 basestations in service area, 3000 voice end users)

Routine Dispatch - Mobile voice communications with VoIP codex of 15 kbps per channel, inclusive of control communications, with three channels in PTT mode per basestation, mobile data limited to ~200 kbps maximum (110 basestations in service area, 3000 voice end users)

Work Management - Mobile Workforce Management communications from head-end management system to ~2000 vehicle mounted PCs primarily composed of work ticket information (56 kbps) but map and file updates require higher bandwidth (256 kbps)

Black Start Operations - Mobile and point-to point voice communications with VoIP codex of 15 kbps per channel, inclusive of control communications, with only one channel operating in PTT mode, no mobile data provided (10 fixed and command center sites in service area, 300 black start voice end users)

Future communications needs should be estimated based on a 5 year projection.

Functional Requirements		
AC Independence	After the loss of electric service what applications need backup power to provide restoration and for how long (measured in minimum hours)
Bandwidth	Estimated or tested data rates are required to support this application during normal and emergency conditions (measured in kilobits per second (kbps) at the node or collection point
Coverage	Geographic areas that these networks are required to operate (estimated percentage of service territory)
Latency	How quickly does field data need to be updated (measured in milliseconds (ms) from endpoint-to-endpoint (i.e. not roundtrip))?
Reliability	How many service interruptions are tolerated and how well must this network provide accurate data (as a percentage of overall traffic (e.g. 99.999%)
Security	How secure must the network be from cyber and physical attacks (one a scale of 1-5 with 1 being low and 5 being high)

Technology Options		
Licensed Wireless Radio	Private licensed wireless radio networks operating under Part 90 of the FCC rules **(LMRS two-way radio/pt to multi-pt services)**
Licensed Wireless Microwave	Private licensed wireless microwave networks operating under Part 101 of the FCC rules **(microwave point-to-point networks)**
Unlicensed Wireless	Private unlicensed wireless radio networks operating under Part 15 of the FCC rules **(802.11x wireless LAN (e.g. WiFi) / 802.15x PANs (e.g. Zigbee)**
Fiber	Private fiber networks owned or controlled by a utility
Other Private Network	Private networks that are neither fiber nor wireless, such as powerline carrier
Commercial Wireless Network	Commercial networks that operate using licensed radio under Part 22 of the FCC rules **(e.g. Verizon, AT&T, Sprint, etc. carrier networks)**
Commercial Wireline Network	Commercial networks that use any wireline technology, including fiber, DSL, coax or traditional twisted pair copper circuits
Satellite	Satellite includes all types of fixed and mobile satellite services, including Very Small Aperture Terminals (VSATs) and satellite phones

Smart Grid Network Tiers

Tier 1 – Core Backbone

The core communications network is the primary path to the utility data center and data processing infrastructure. The core may also be the transport for enterprise applications and will typically be architected in a self-healing ring topology or point-to-point with backup circuit redundancy. The core may have points-of-presence in substations and other company

Tier 2 – Backhaul

The backhaul tier will aggregate the field area network including collectors, RF access points, data concentrators, etc. from the field access tier of the network and provide a delivery transport bridge to the core backbone tier.

Tier 3A – Access (to end-points or collectors/gateways/take-out-points (if present))

At this tier end-point devices or collectors/gateways/take-out-points will gain access to the network. It is commonly referred to as the last mile communication or Field Area Network and will be relatively low bandwidth for hand off to the Backhaul Tier.

Tier 3B – Access (to endpoints when a collector/gateway/take-out-point is present to aggregate end-points)

At this tier end-point devices will gain access to the collector/gateway/take-out-point. It is commonly based upon some form of proprietary communications on unlicensed spectrum or powerline carrier technologies.

Tier 4 – Home Area Network (HAN)

In home devices will typically communicate with the Access tier through various technologies. The HAN has not yet converged on a standard but is likely to consist of technologies like Zigbee or HomePlug which may connect directly with communication Tier 3A or Tier 3B.