THE FUTURE OF SMART GRID COMMUNICATIONS

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CTO – STRATEGIC INDUSTRIES
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Alcatel·Lucent

THE GRID OF THE FUTURE...

WIDE-SCALE DEPLOYMENT OF RENEWABLES

INCREASED ENERGY EFFICIENCY

PEAK POWER REDUCTION, DEMAND RESPONSE

THE GRID OF THE FUTURE...

IMPROVED RELIABILITY

LOWER ENERGY
DELIVERY COSTS

CONSUMER
PARTICIPATION

THE GRID OF THE FUTURE...

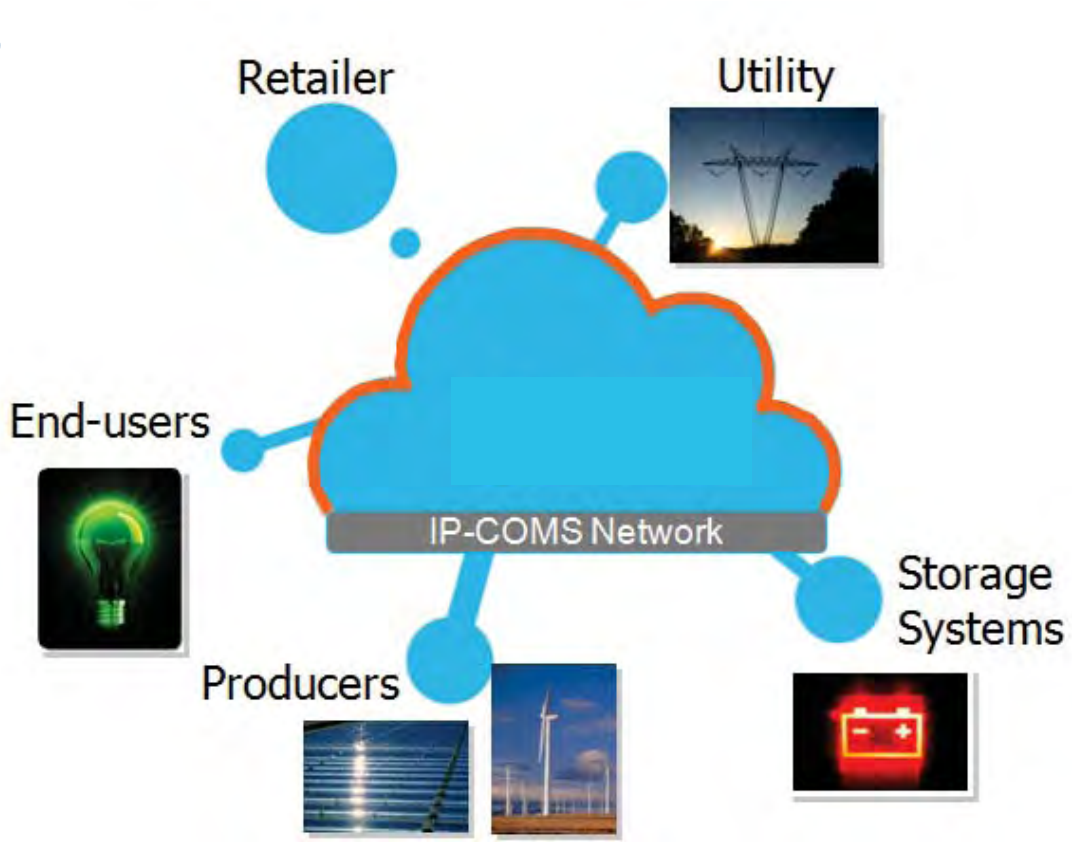
PERVASIVE DISTRIBUTED ENERGY RESOURCES

MARKET RETAIL TRANSACTIONS

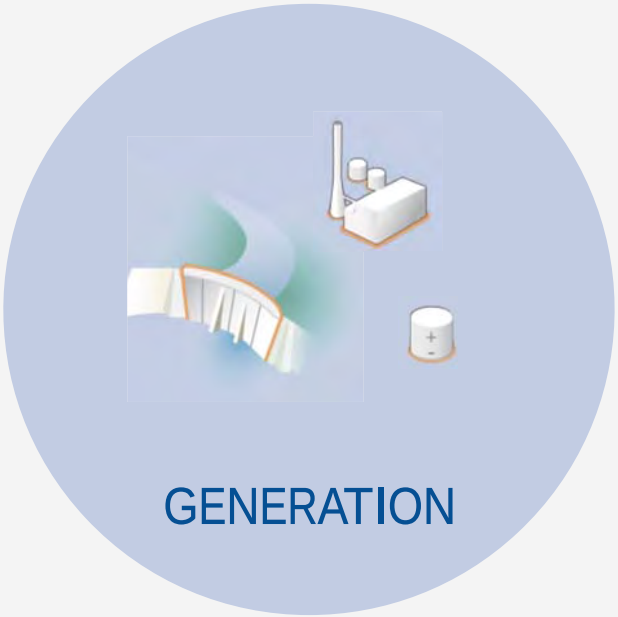
MICROGRIDS

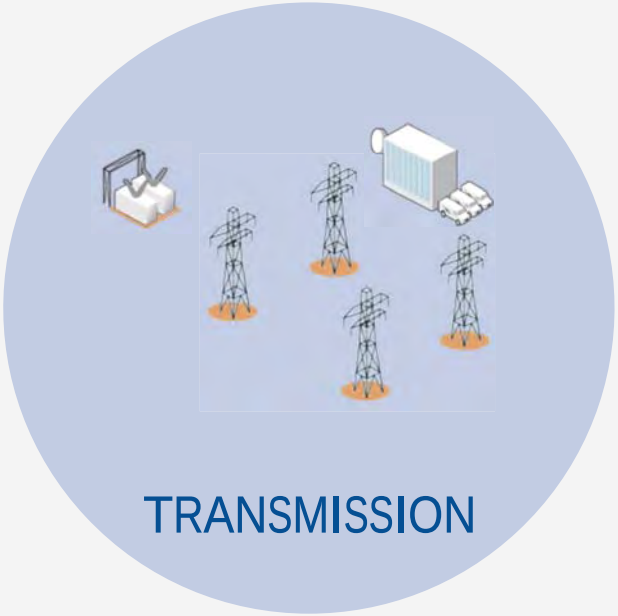
DISTRIBUTED CONTROL

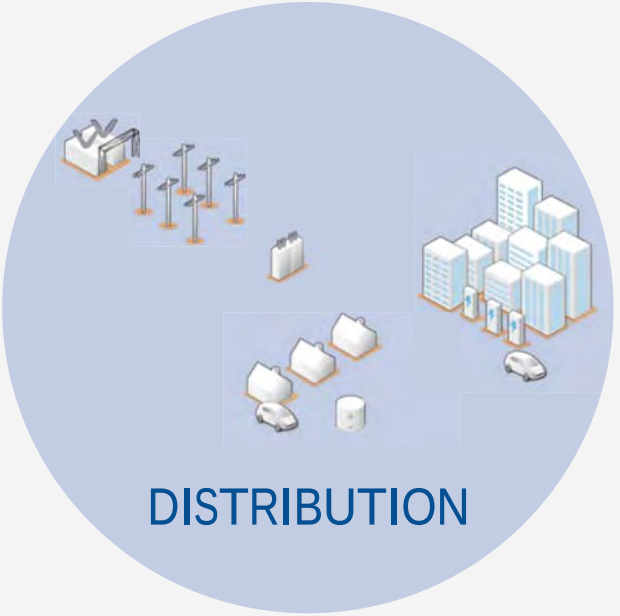
DATA ANALYTICS



TRADITIONAL POWER GRID







TRADITIONAL GRID APPLICATIONS

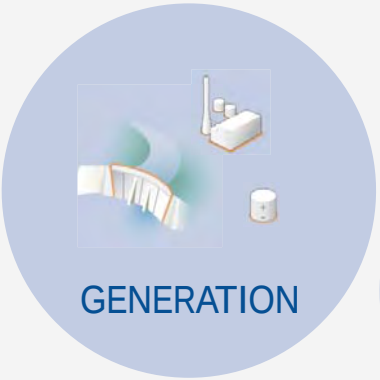
TELEPROTECTION

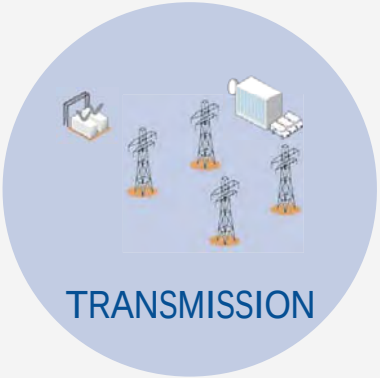
SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

MOBILE WORKFORCE

ENTERPRISE VOICE & DATA

- **SUPPLY-DEMAND BALANCE**
- **SAFETY**
- **EFFICIENCY**

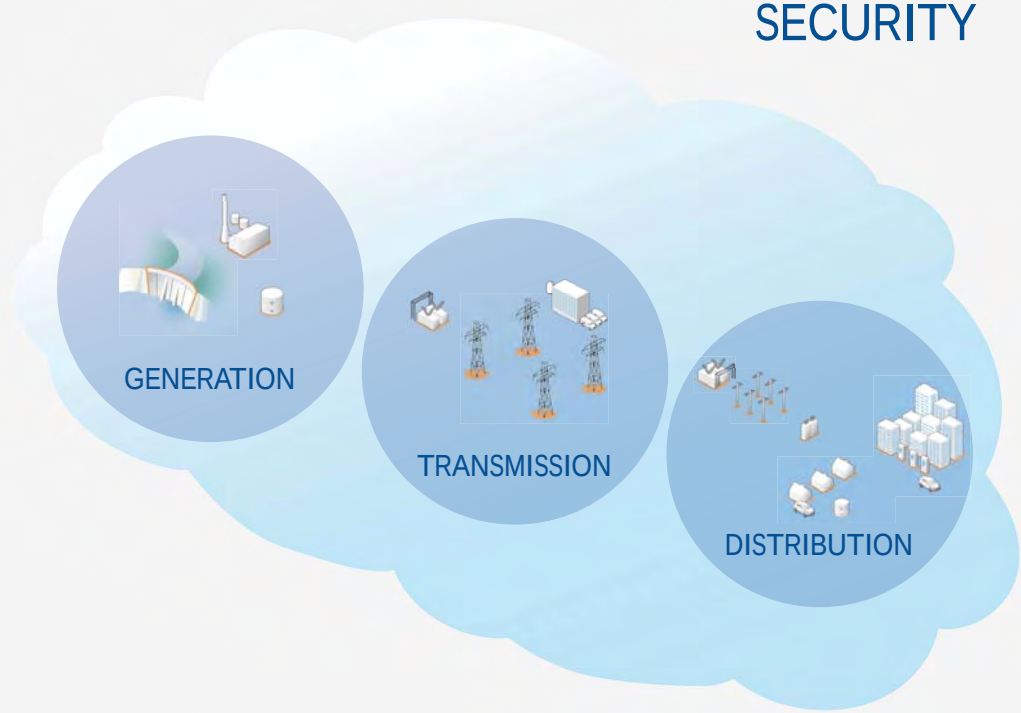




TRADITIONAL GRID COMMUNICATIONS NETWORKS

- SMALL NUMBER OF ENDPOINTS
- MULTIPLE, SILOED NETWORKS
- LOWSPEED WIRELINE, WIRELESS
- LIMITED CONNECTIVITY BEYOND THE SUBSTATION

MISSION-CRITICAL RELIABILITY, PERFORMANCE, SECURITY



ICT FOR SMART GRID: FORCES OF CHANGE

DISTRIBUTED GENERATION & STORAGE

DISTRIBUTED SENSORS & CONTROLLERS

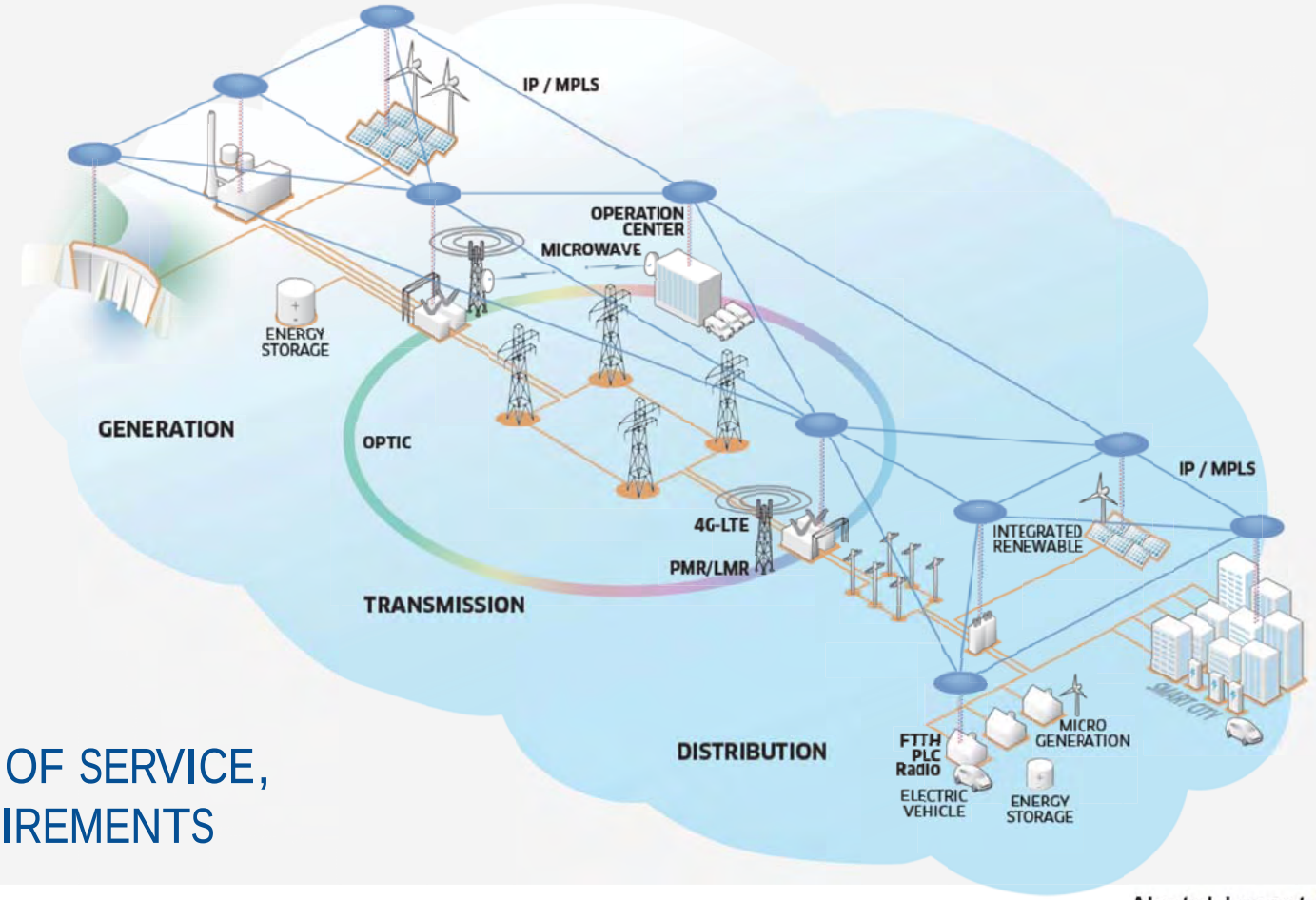
- Distribution Automation
- Automated Demand Response
- Microgrids
- Electric Vehicles
- Retail Energy Markets
- Dynamic Line Rating
- Wide Area Monitoring And Control
- ...

NEW APPLICATIONS

NEW SECURITY THREATS (PHYSICAL, CYBER)

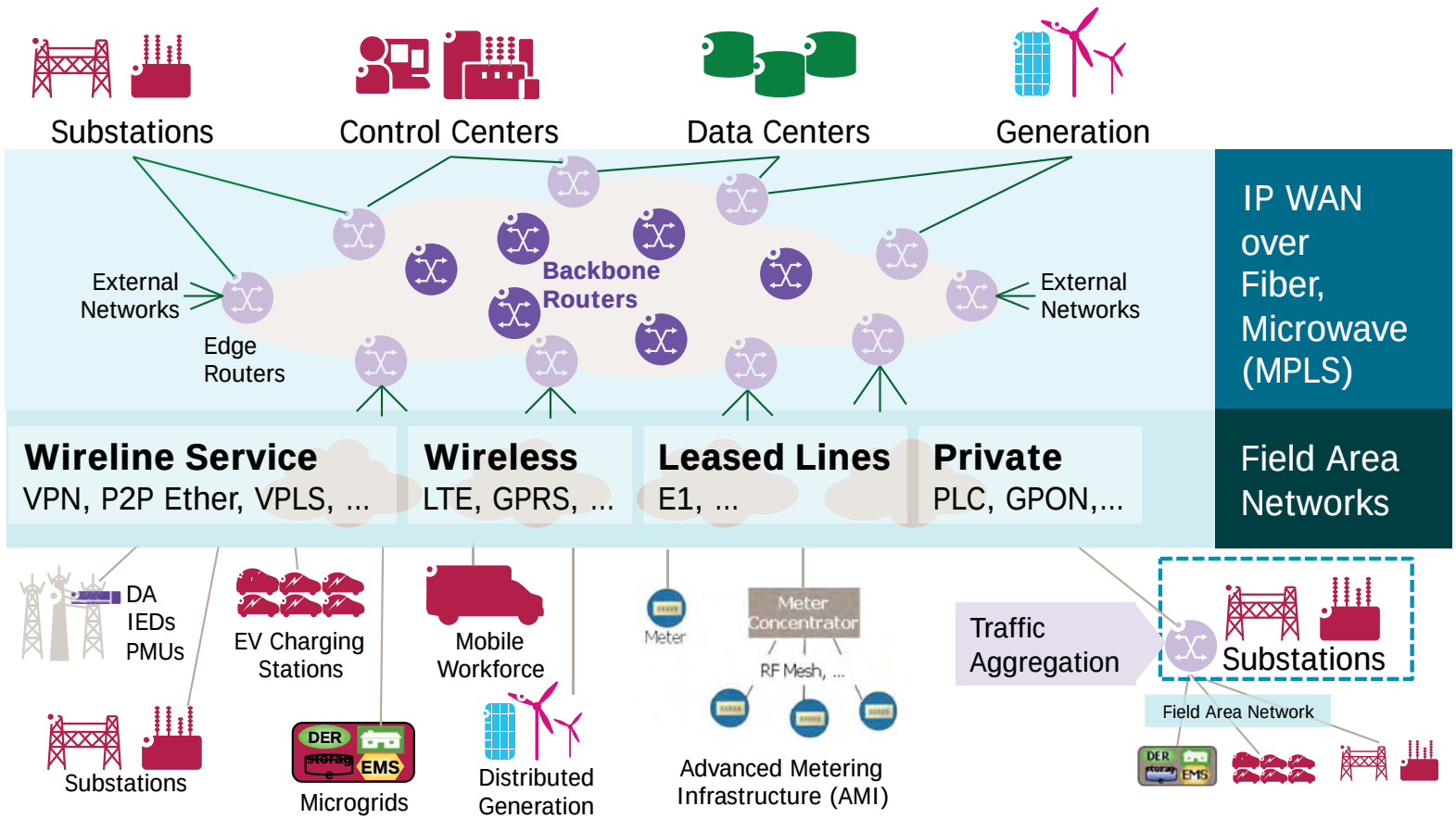
SMART GRID

- ENDPOINTS^{++}
- BANDWIDTH^{++}
- DATA^{++}
- DATA SHARING^{++}
- SUPPLY-DEMAND VARIABILITY^{++}
- UNIVERSAL CONNECTIVITY
- DIVERSE QUALITY OF SERVICE, RELIABILITY REQUIREMENTS



TOMORROW'S ELECTRIC GRID

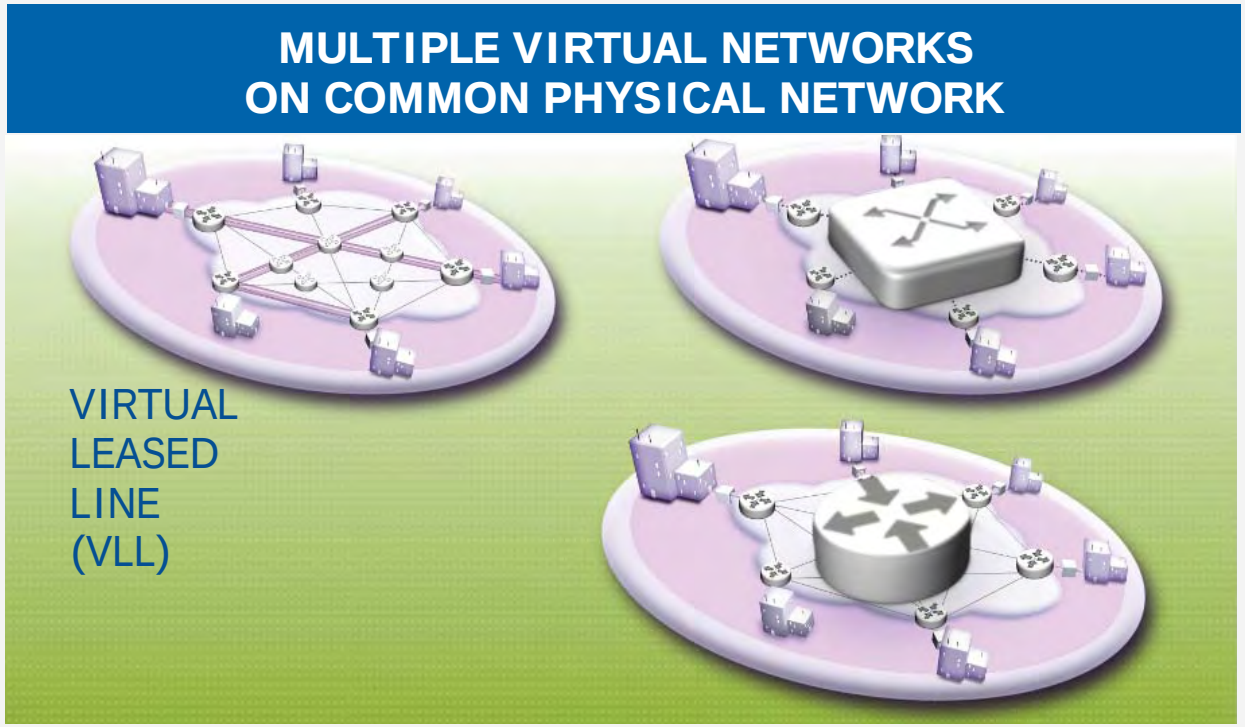
CONVERGED COMMUNICATIONS NETWORK



- ALL-IP (IP/MPLS) INFRASTRUCTURE
- SUPPORT OF LEGACY APPS AND INTERFACES
- SCALABILITY
- MULTIPLE LAST-MILE OPTIONS
- MISSION-CRITICAL PERFORMANCE, RELIABILITY, SECURITY

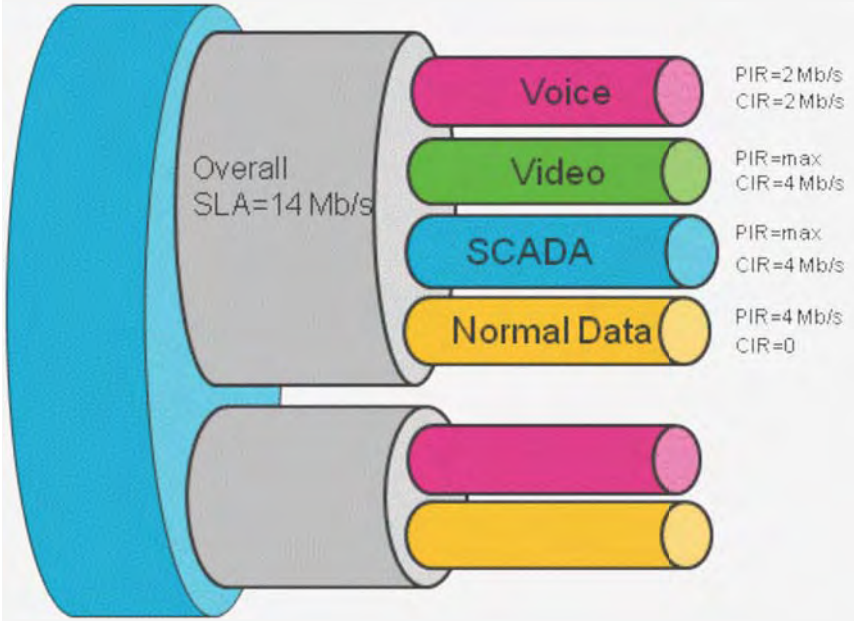
IP/MPLS MISSION CRITICAL NETWORK FEATURES
VIRTUAL NETWORKS

- Traffic Isolation
- Confidentiality
- Integrity
- Support of Legacy TDM interfaces



IP/MPLS MISSION CRITICAL NETWORK FEATURES

HIERARCHICAL QOS



LESS OVERALL BANDWIDTH REQUIRED
→LOWER OVERALL COST

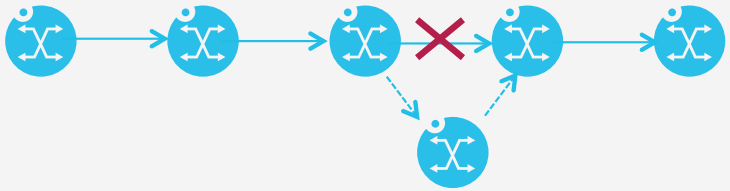
PRIORITY AND BEST-EFFORT
TRAFFIC EQUALLY WELL SERVED

PREDICTABLE PERFORMANCE

IP/MPLS MISSION CRITICAL NETWORK FEATURES
FAST RE-ROUTE, TRAFFIC ENGINEERING

FAST RE-ROUTE

<50 ms restoration

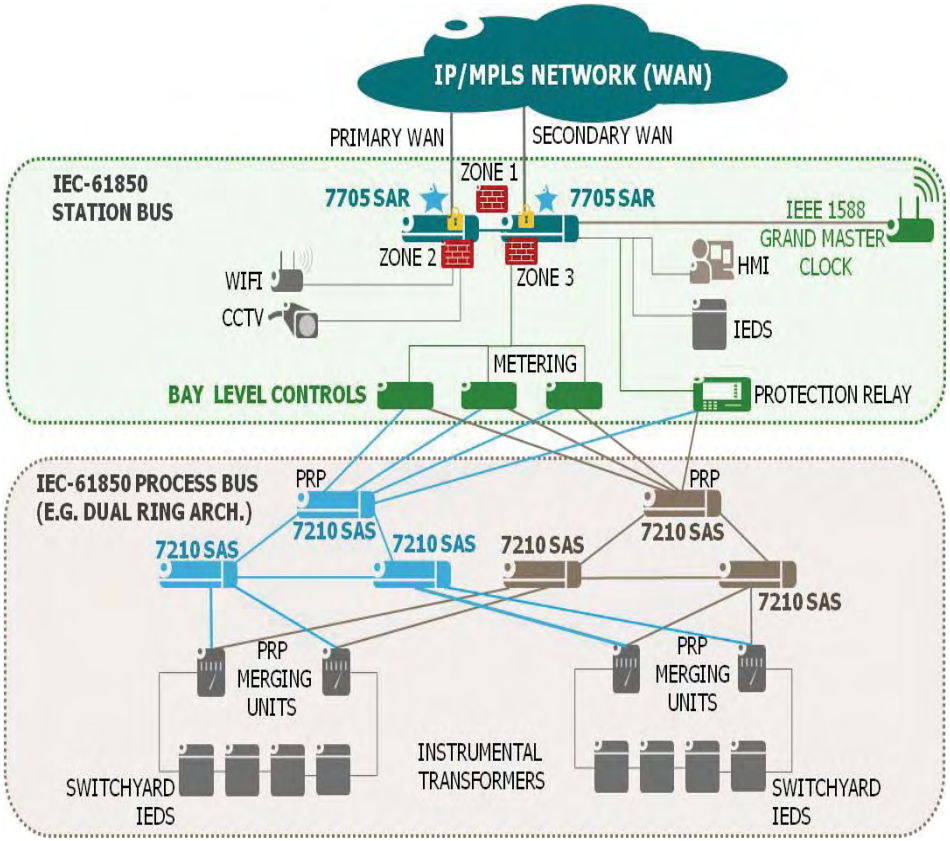


PROTECTION AGAINST MULTIPLE FAILURES

TRAFFIC ENGINEERING

- SELECTION OF BEST PATH
- BANDWIDTH RESERVED END-TO-END

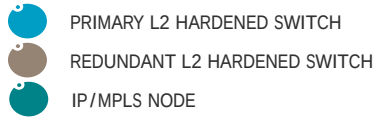
TOMORROW'S ELECTRIC GRID
SUBSTATION DIGITALIZATION



- STANDARDIZED, IP-BASED CONTROL AND MONITORING (IEC-61850)
- STATE-OF-THE-ART CYBER-SECURITY

- SECURE NETWORK ACCESS FOR FIELD PERSONNEL

- VIDEO MONITORING, ACCESS CONTROL
- REDUNDANCY, RELIABILITY



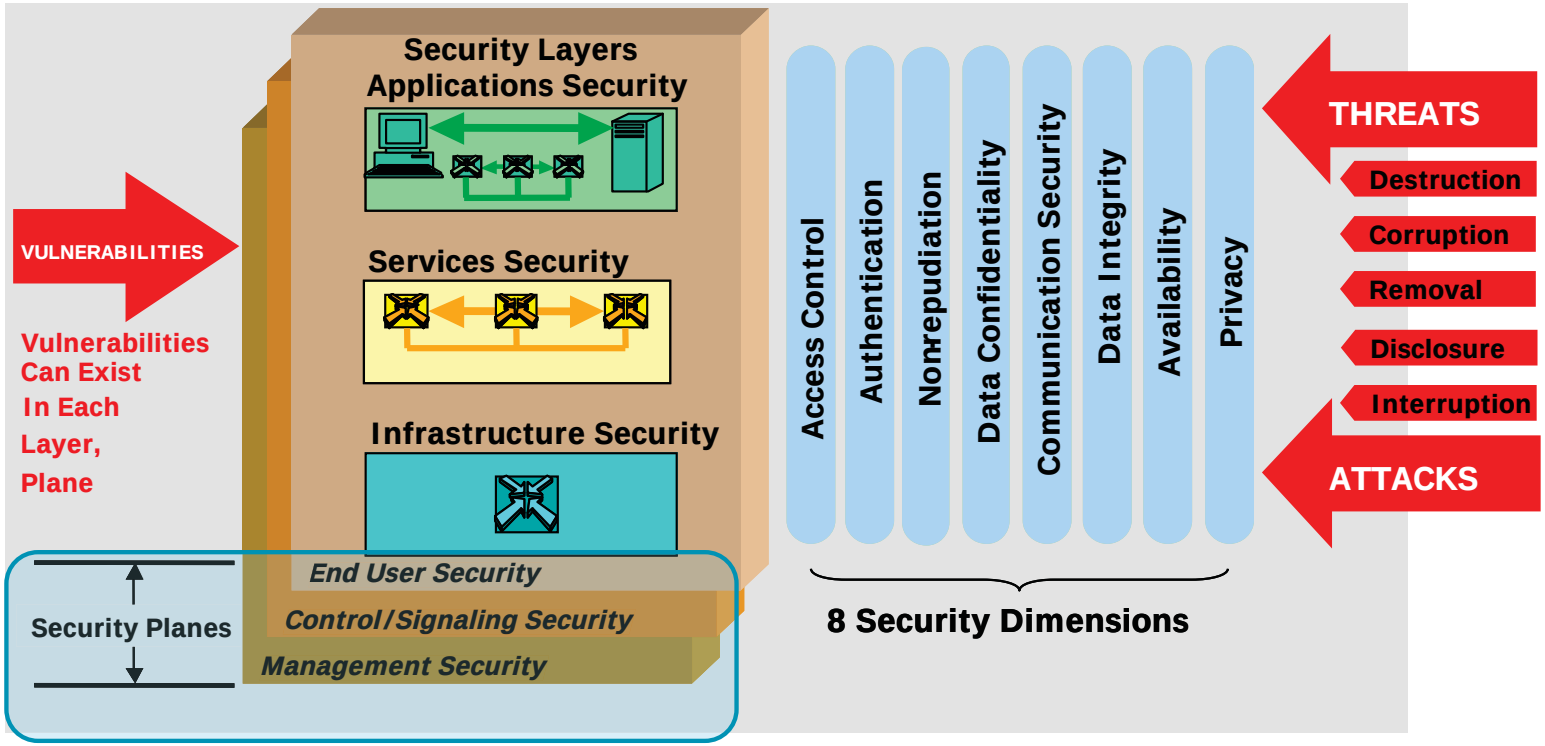
TRENDS IN SECURITY THREATS

more destructive

more complex

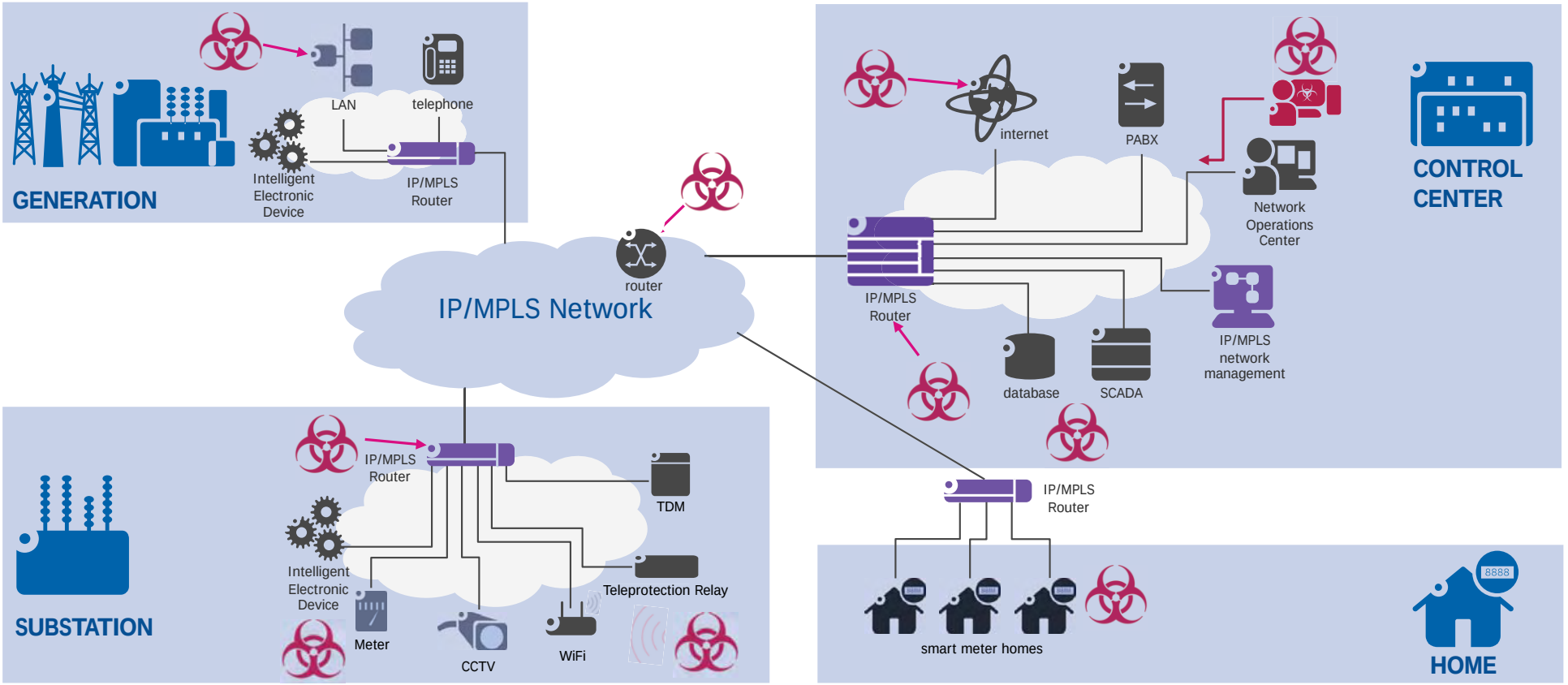
more frequent

ITU-T X.805 SECURITY ARCHITECTURE FOR COMMUNICATIONS SYSTEMS PROVIDING END-TO-END SECURITY

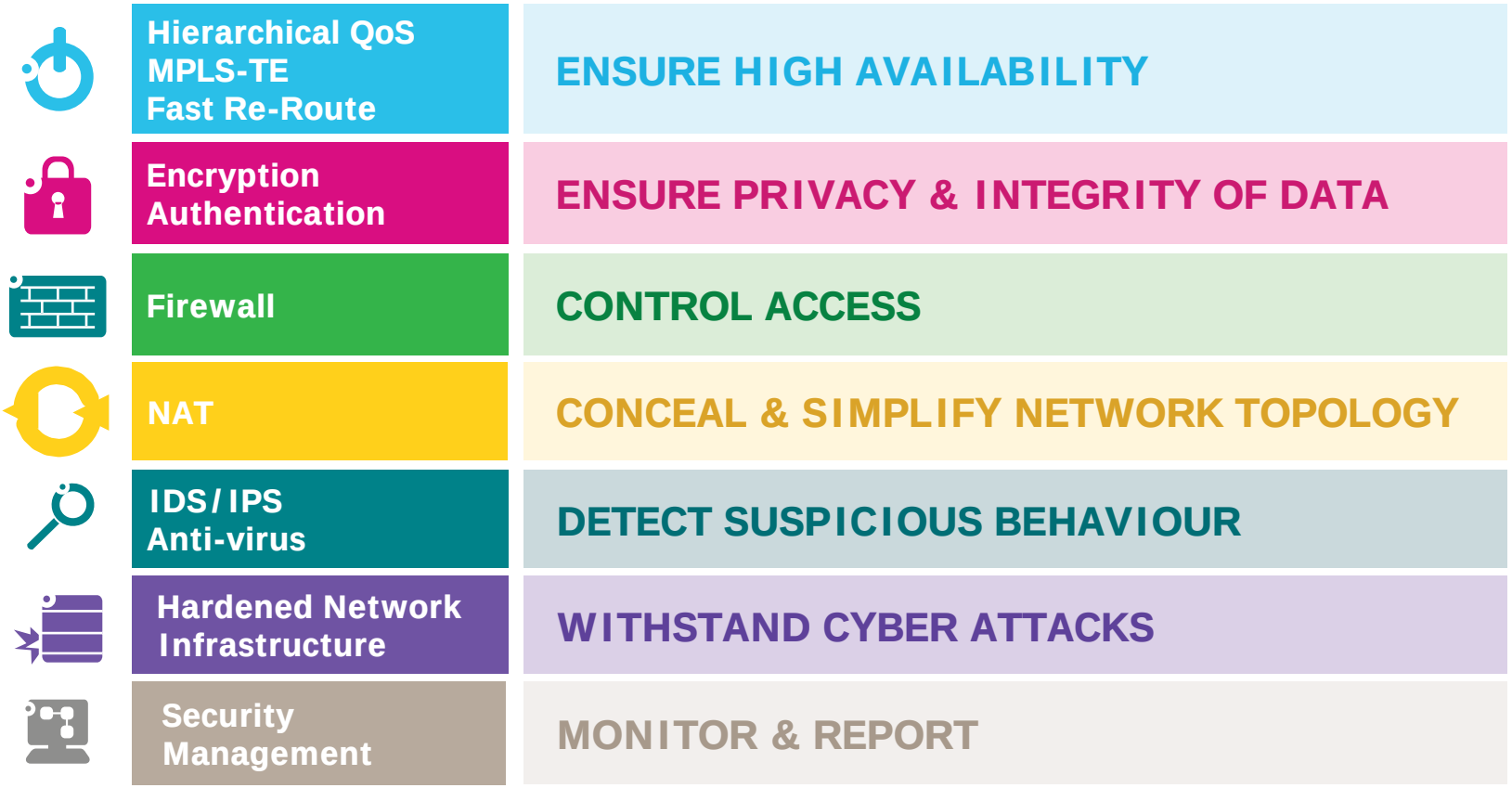


GLOBAL SECURITY STANDARD DEVELOPED BY BELL LABS

CYBER ATTACK ENTRY POINTS

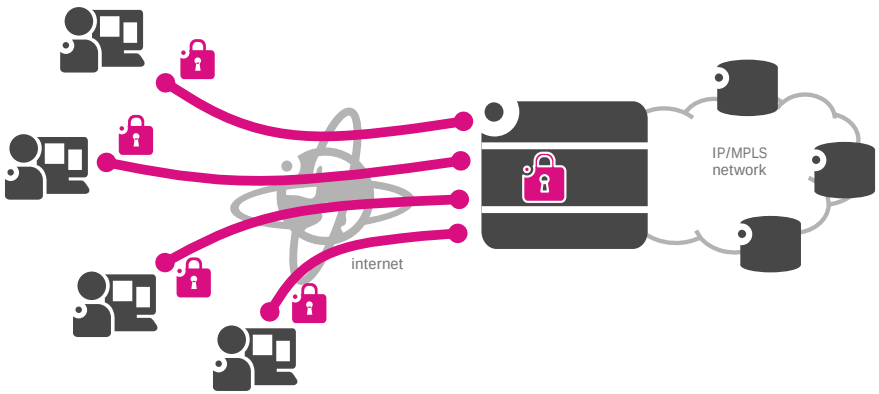


END-TO-END SMART GRID COMMUNICATIONS NETWORK SECURITY



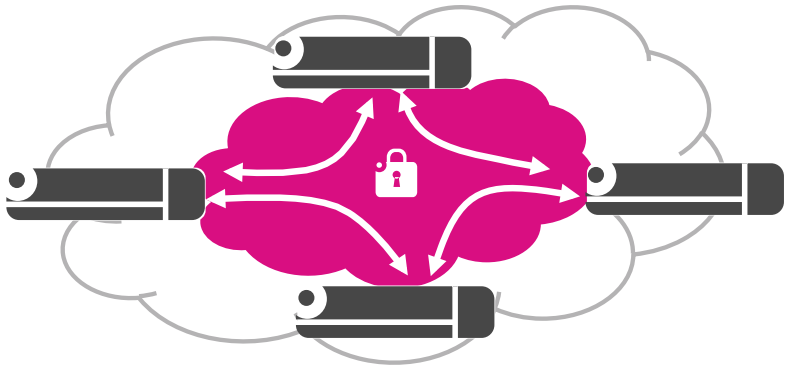
ENCRYPTION

POINT-TO-POINT



OLD GRID

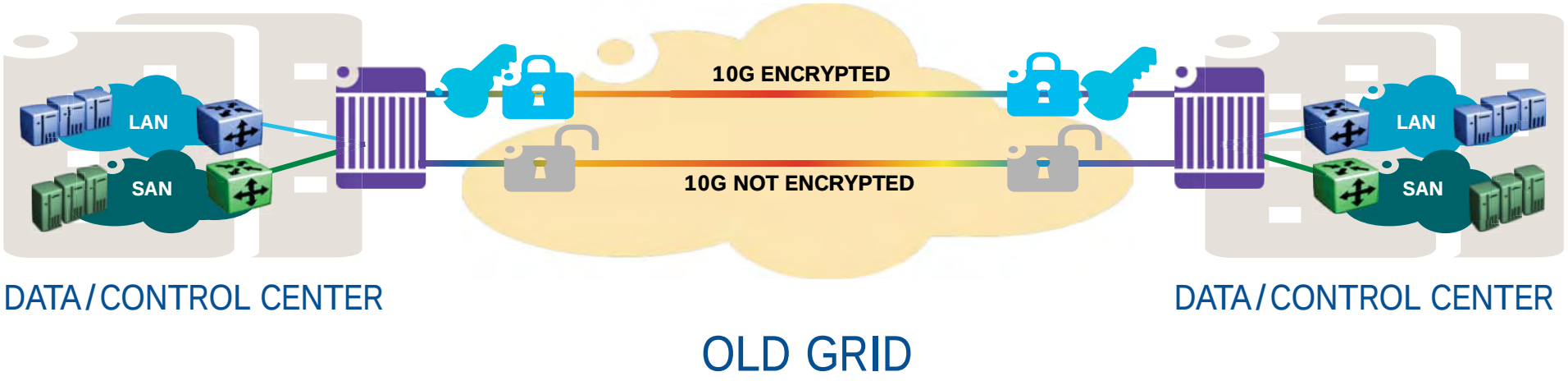
ANY-TO-ANY



SMART GRID

OPTICAL LAYER ENCRYPTION

SECURE, IN-FLIGHT PROTECTION OF MISSION-CRITICAL DATA



FIREWALLS

OLD GRID

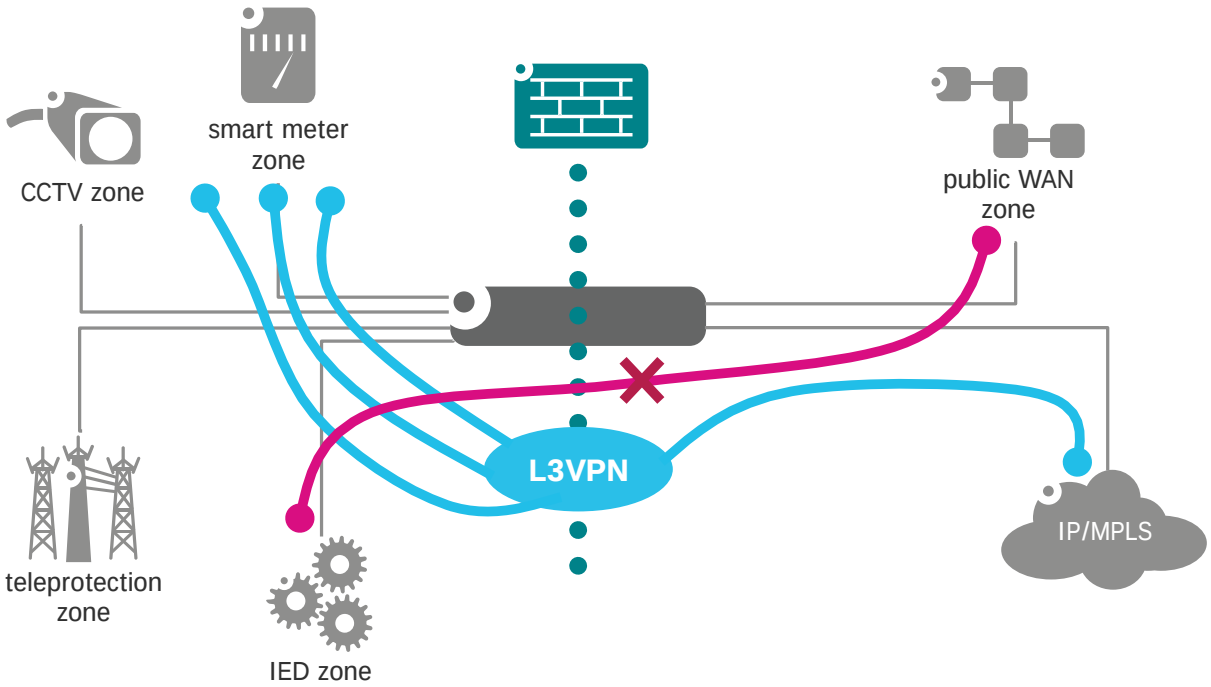
ACCESS CONTROL LISTS

STATELESS FIREWALL

STATEFUL FIREWALL

SERVICE-AWARE ZONE-BASED STATEFUL FIREWALL

SMART GRID

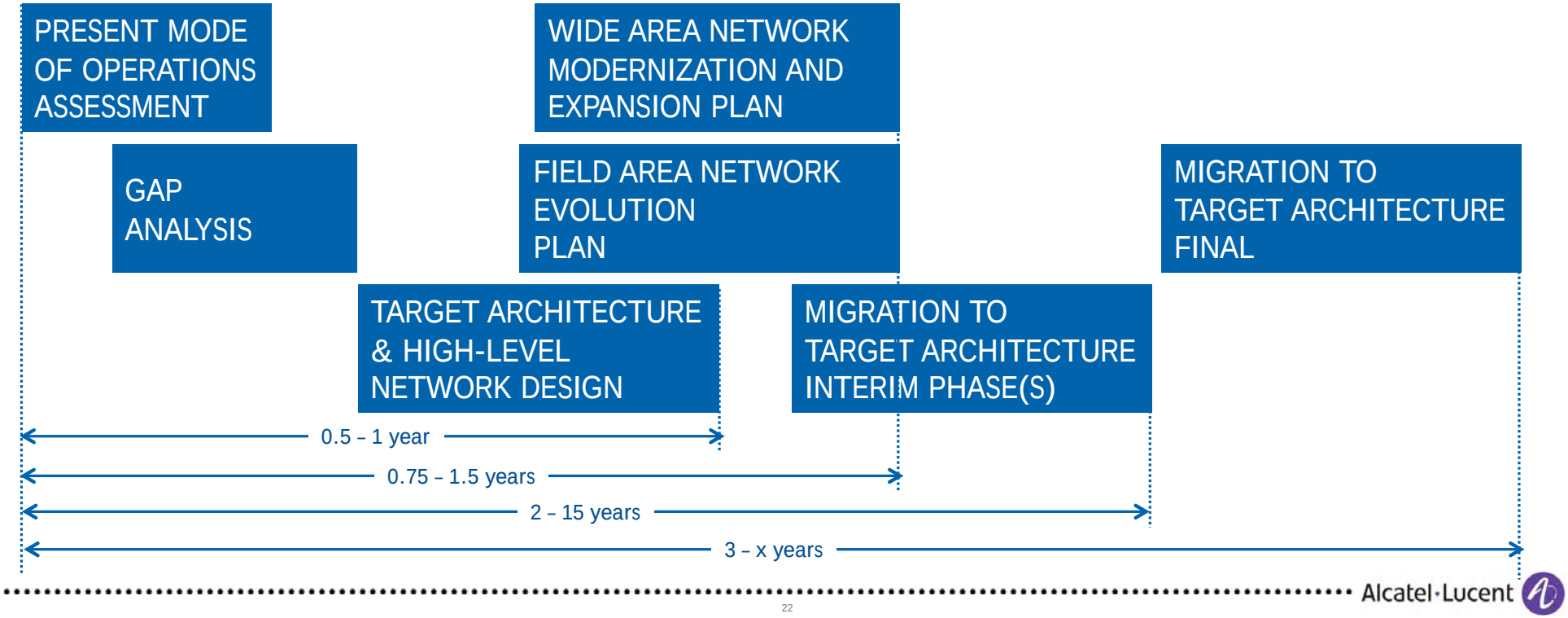


SMART GRID

SMART GRID COMMUNICATION NETWORK TRANSFORMATION

MAKING IT REAL

- INTRODUCTION OF NEW GRID APPS
- REDUCED TOTAL COST OF OWNERSHIP



BELL LABS AND SMART GRID

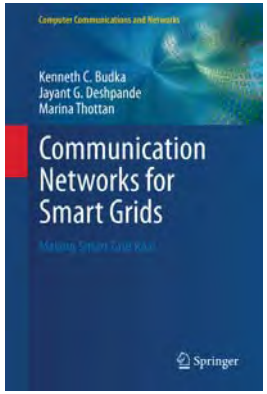
NEXT-GENERATION SMART GRID COMUNICATIONS

Pervasive Distributed Energy Resources

Microgrids

Market Retail Transactions

SMART GRID NETWORK TRANSFORMATION

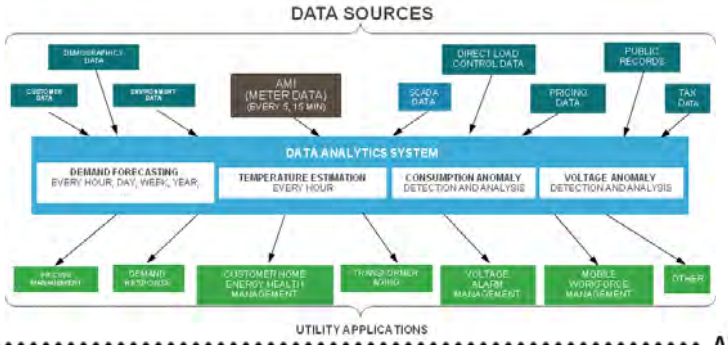


E-MOBILITY

Demand Management

ICT for Charging

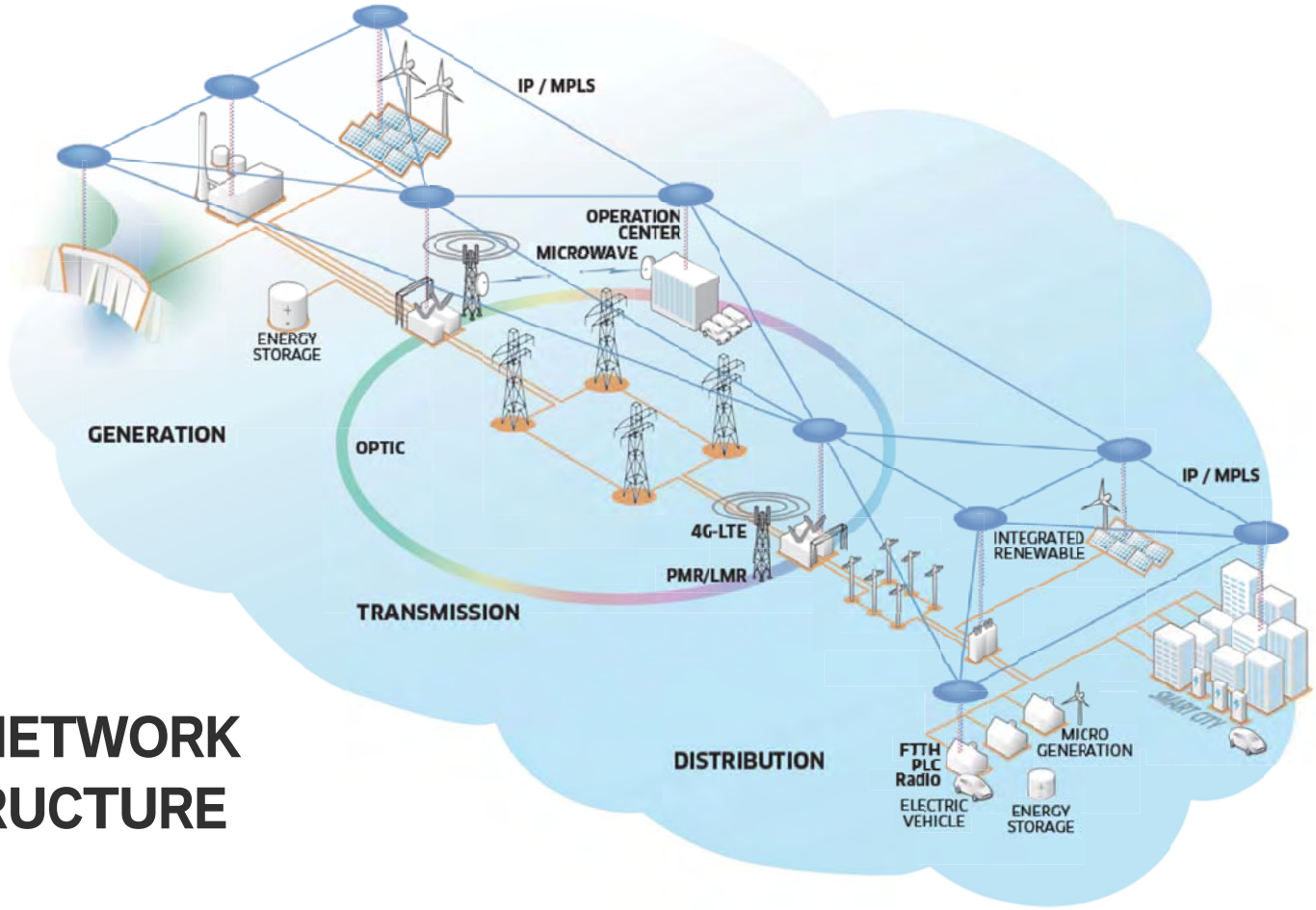
SMART GRID DATA ANALYTICS



THE FUTURE GRID RELIES UPON A

- HIGH-PERFORMANCE
- RELIABLE
- SECURE
- SCALABLE
- UBIQUITOUS
- COST-EFFECTIVE

COMMUNICATIONS NETWORK AND DATA INFRASTRUCTURE



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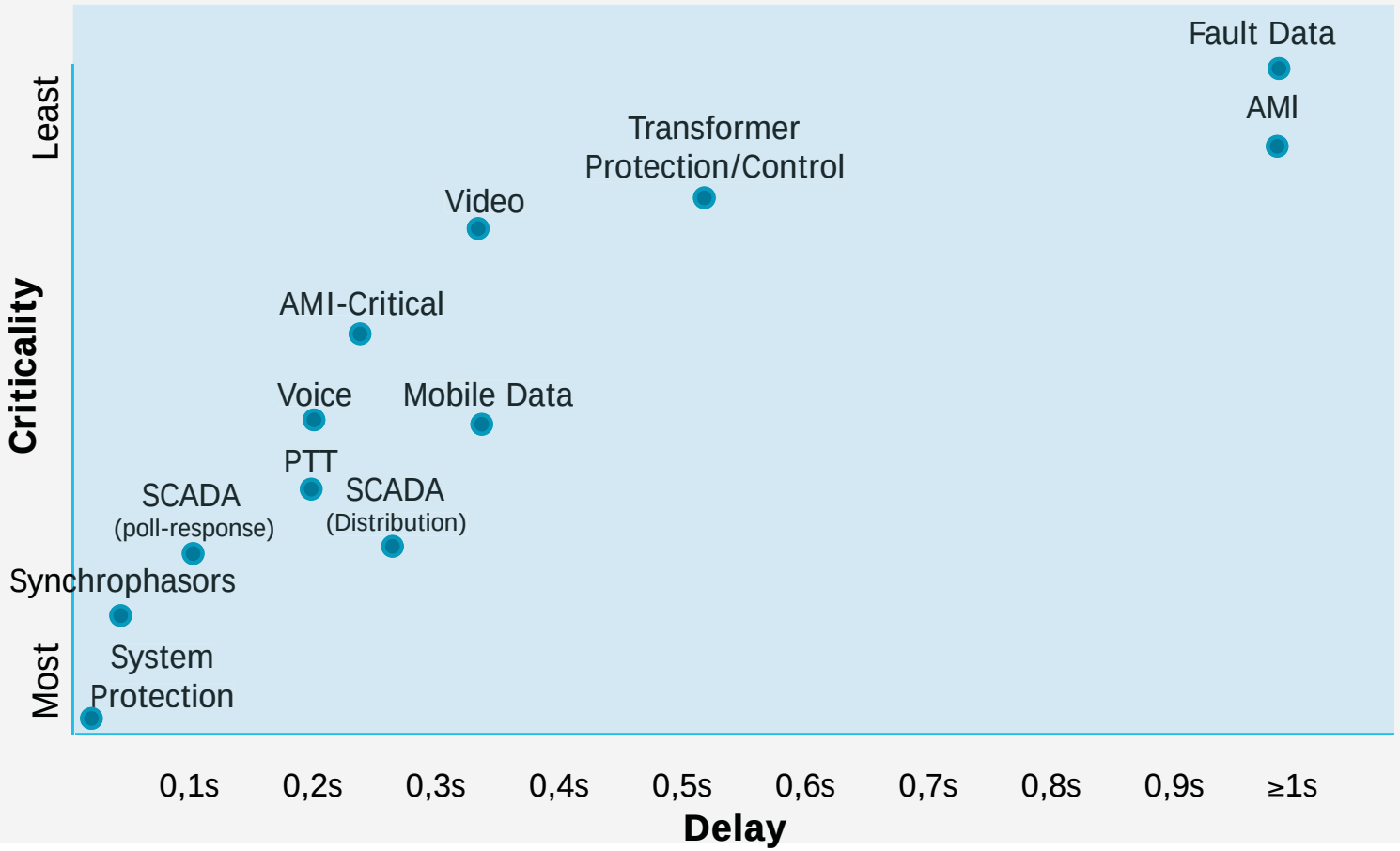
GRID APPLICATIONS



DIVERSE QoS, RELIABILITY REQUIREMENTS