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PANEL on FUTURE COMPUTATION / COMPUTATIONAL TOOLS

Challenges in Future Computation Techniques and Tools

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Panel structure

- Moderator
- **Alexander Gegov, University of Portsmouth, UK**

- Members
- **Wail Mardini, Jordan University of Science and Technology, Jordan**
- **Petre Dini, Concordia University, Canada / China Space Agency Center, China**
- **Alexander Gegov, University of Portsmouth, UK**

Philosophical observations

- **Temporality of challenges**
  - from past to present
  - from present to future

- **Interesting analogies**
  - total football
  - alternative rock
  - personal computers

- **Transition phases**
  - from avangard to mainstream
  - from mainstream to classic

Present and future

- **Present achievements**
- **data retrieval and storage techniques and tools**
- **system modelling and simulation techniques and tools**
- **plus more**

- **Future challenges**
- **from data processing to knowledge discovery**
- **from predictive simulation to preventive control**
- **plus more**

Techniques and tools

- **Future techniques and tools**
- **better qualitative functionality**
- **smarter user interfaces**
- **plus more**

- **Potential applications**
- **prediction of crime and terrorism**
- **warning about natural disasters**
- **analysis of health risks**
- **forecasting of financial crises**
- **plus more**

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Challenges in Future Computation Techniques and Tools

Prof. Dr. Petre DINI

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Basics

- Centralized, distributed, parallel,
- New trends

- technology: quantum, molecular, nano
- location: mobile computing, ubiquitous, sensor
- architectural: cloud computing, grid, on-demand
- media: embedded computing, …
- ….
- ….

Other terms

- **Mechanisms-oriented computing**

  Spatial computation; Elastic computing; Human-centered computing; Embedded computing; Entertainment computing; Time-sensitive/temporal computing; Soft computing (fuzzy logic, neural computing, evolutionary computation, machine learning, and probabilistic reasoning + belief networks, + chaos theory + learning theory)

- **Large-scale computing**

  Distributed computing; Parallel computing; Macro- and micro-computing; Activity-based computing; Data-intensive computing; Resource-constraint computing; Grid computing; Cloud computing; Cluster computing; On-demand computing; Ubiquitous/pervasive computing; Memristor Computing; Unconventional computing;

  Evolutionary computing

What triggered this?

- Increasing power computation
- Increasing memory

- Volume of data

- Security/trust/privacy

What is next?

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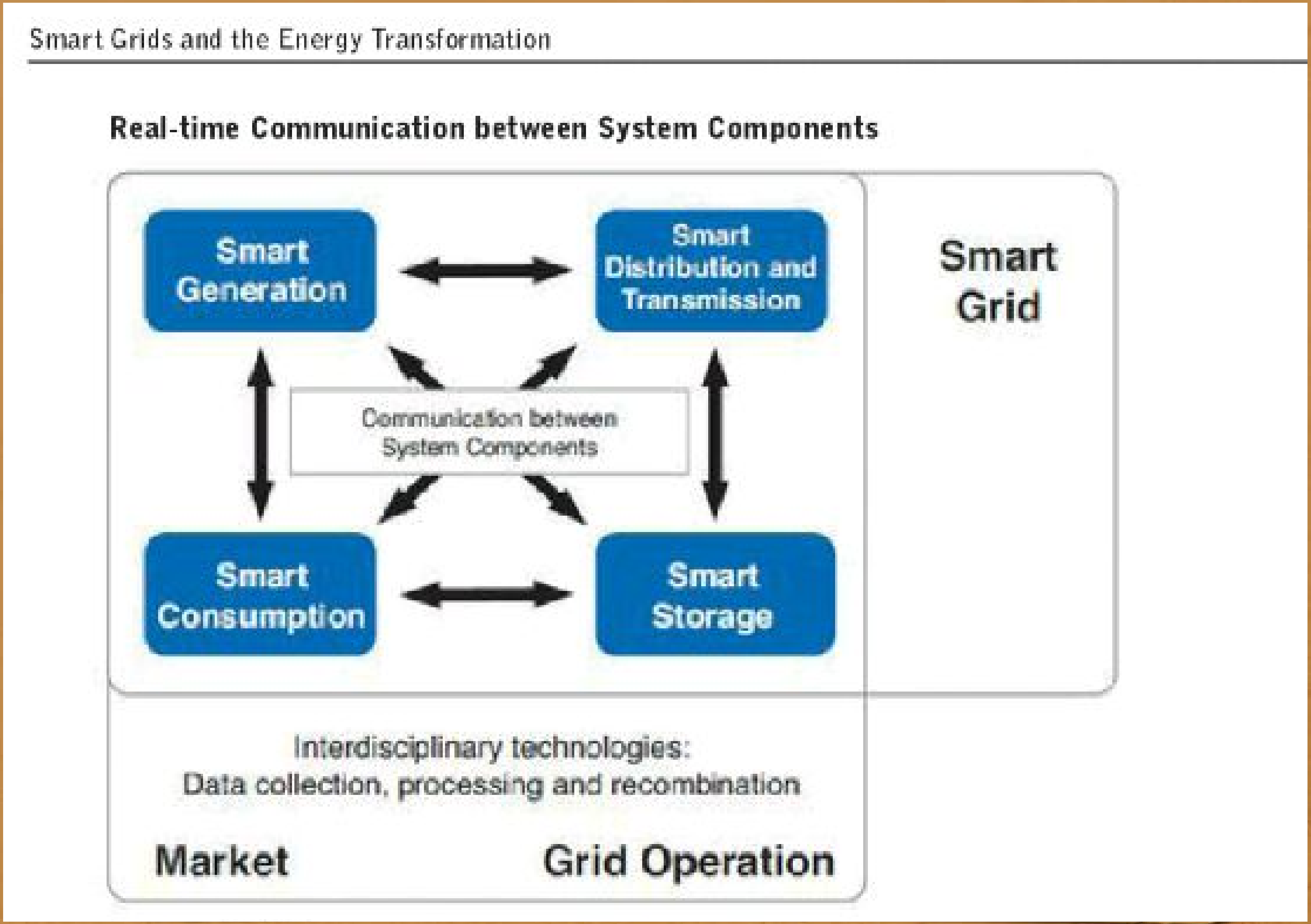
FUTURE; SMART WORLD!
Smart grids

Wail Mardini
Jordan University of Science and Technology
Irbid, Jordan



Smart Grids and the Energy Transformation

Real-time Communication between System Components

Smart => more computations and communications?

Typical components of a smart grid include:

-Intelligent appliances capable of deciding when to consume power based on pre-set customer preferences.

This is toward reducing peak loads which has a major impact on electricity generation costs

Early tests with smart grids have shown that consumers can save up to 25% on their energy usage by simply providing them with information on that usage and the tools to manage it.

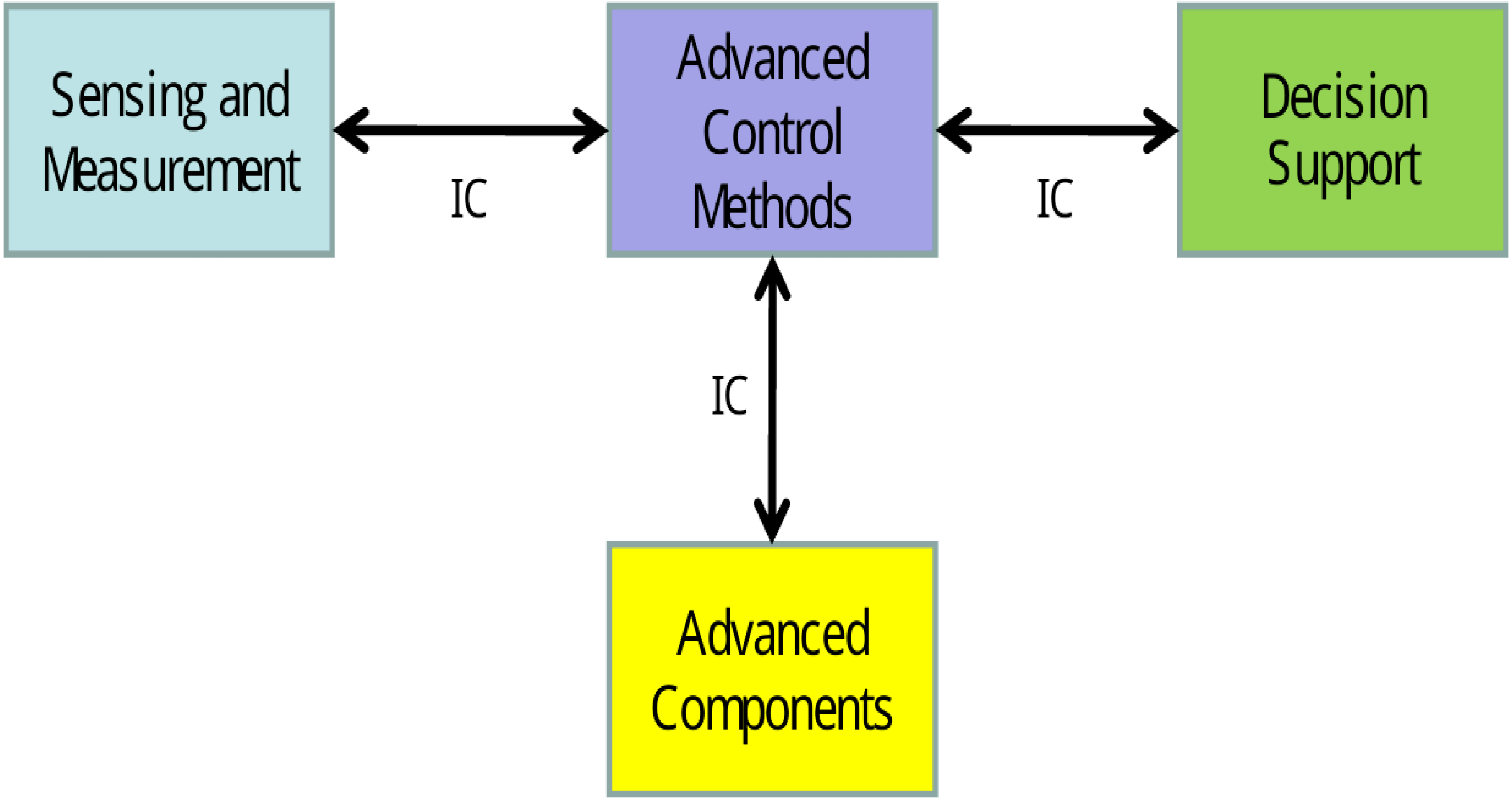
-Smart power meters featuring two-way communications between consumers and power providers to automate billing data collection, detect outages and dispatch repair crews to the correct location faster.

-Smart substations that include monitoring and control of critical and non-critical operational data such as power factor perfonuance, breaker, transformer and battery status, security, etc.

-Smart distribution that is self-healing, self-balancing and self-optimizing including superconducting cables for long distance transmission, and automated monitoring and analysis tools capable of detecting or even predicting cable and failures based on real-time data about weather, outage history, etc.

-Smart generation capable of "learning" the unique behavior of power generation resources to optimize energy production

-Universal access to affordable, low-carbon electrical power generation (e.g., wind turbines, concentrating solar power systems, photovoltaic panels) and storage (e.g., in batteries, flywheels or super-capacitors or in plug-in hybrid electric



Sensing and Measurement

IC

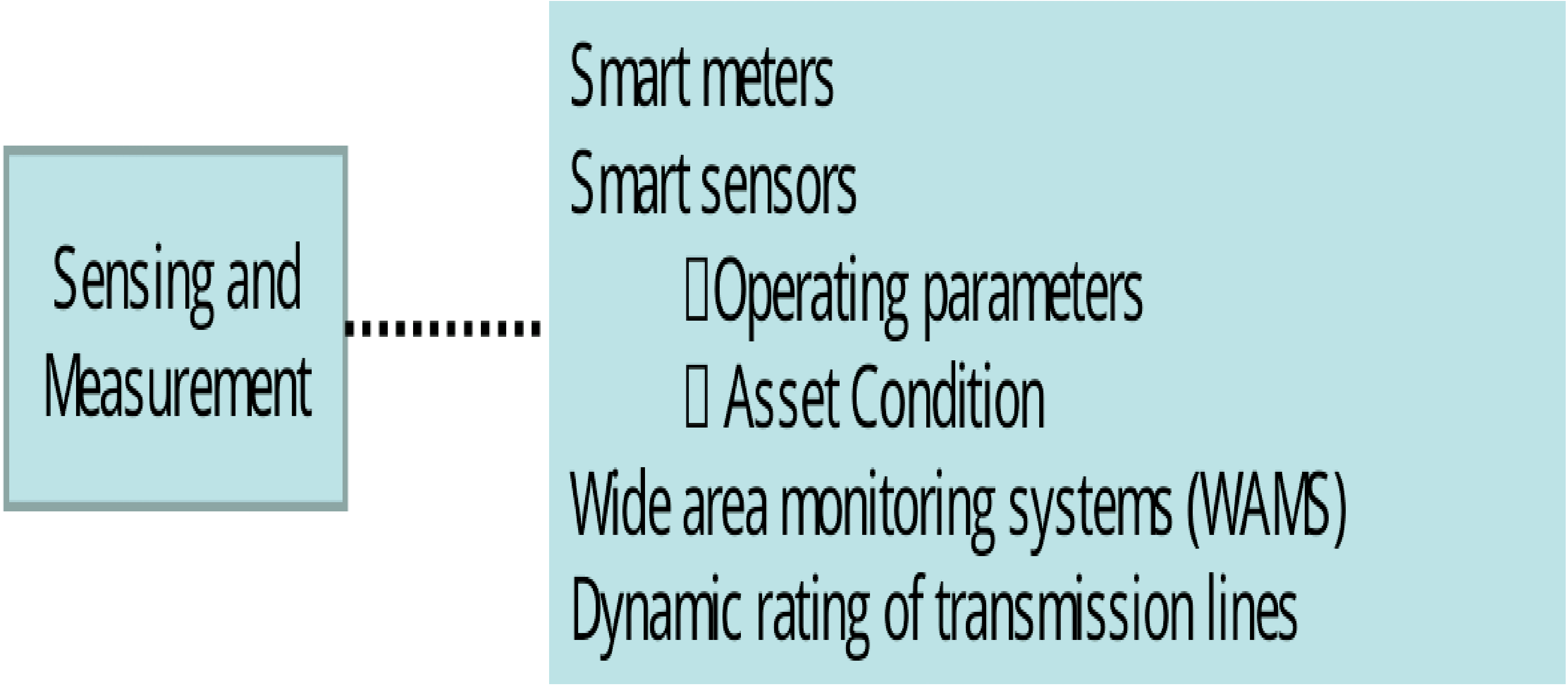
Advanced Control Methods

IC

Decision Support

IC

Advanced Components



Sensing and Measurement

- Smart meters
- Smart sensors
  - Operating parameters
  - Asset Condition
- Wide area monitoring systems (WAMS)
- Dynamic rating of transmission lines

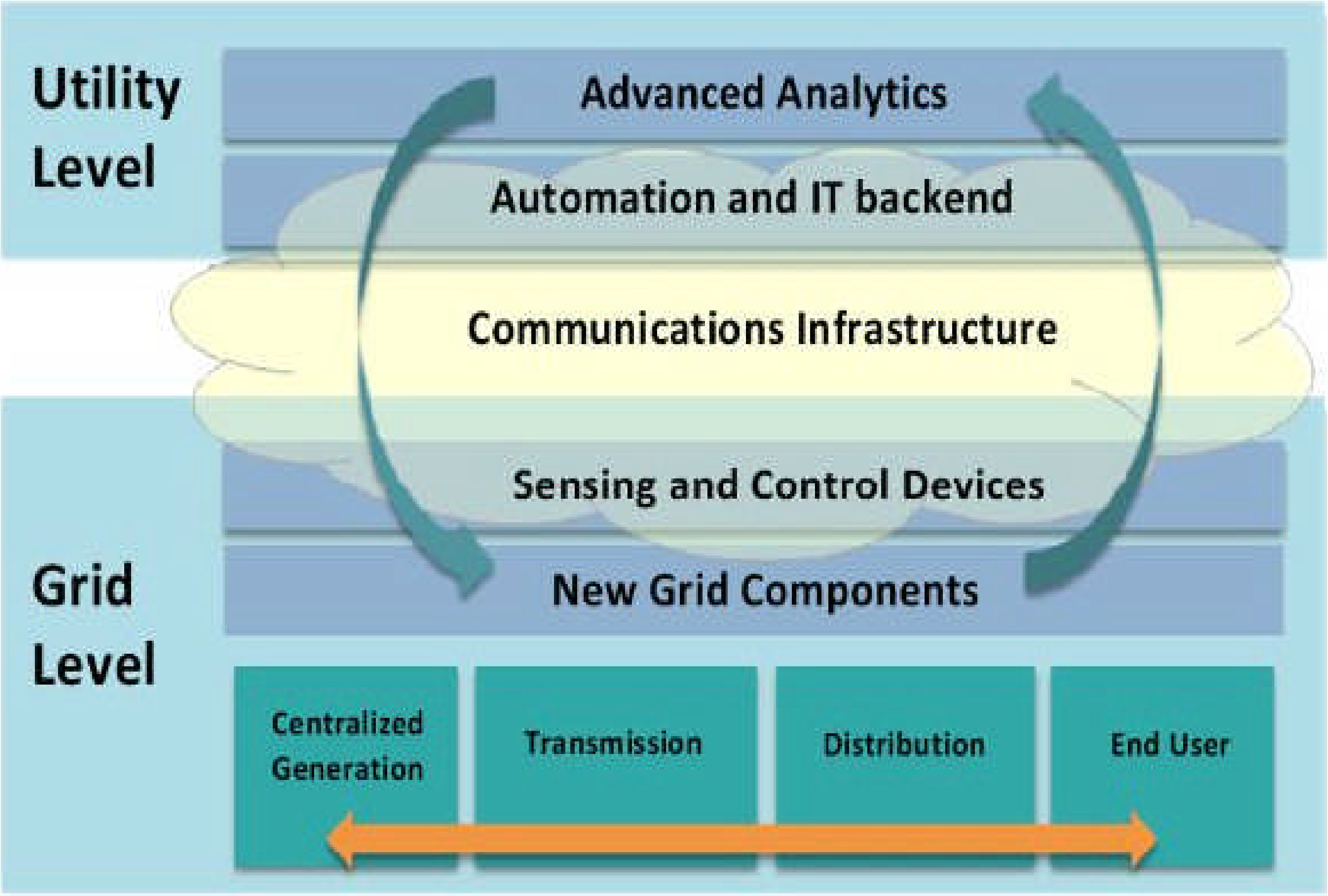
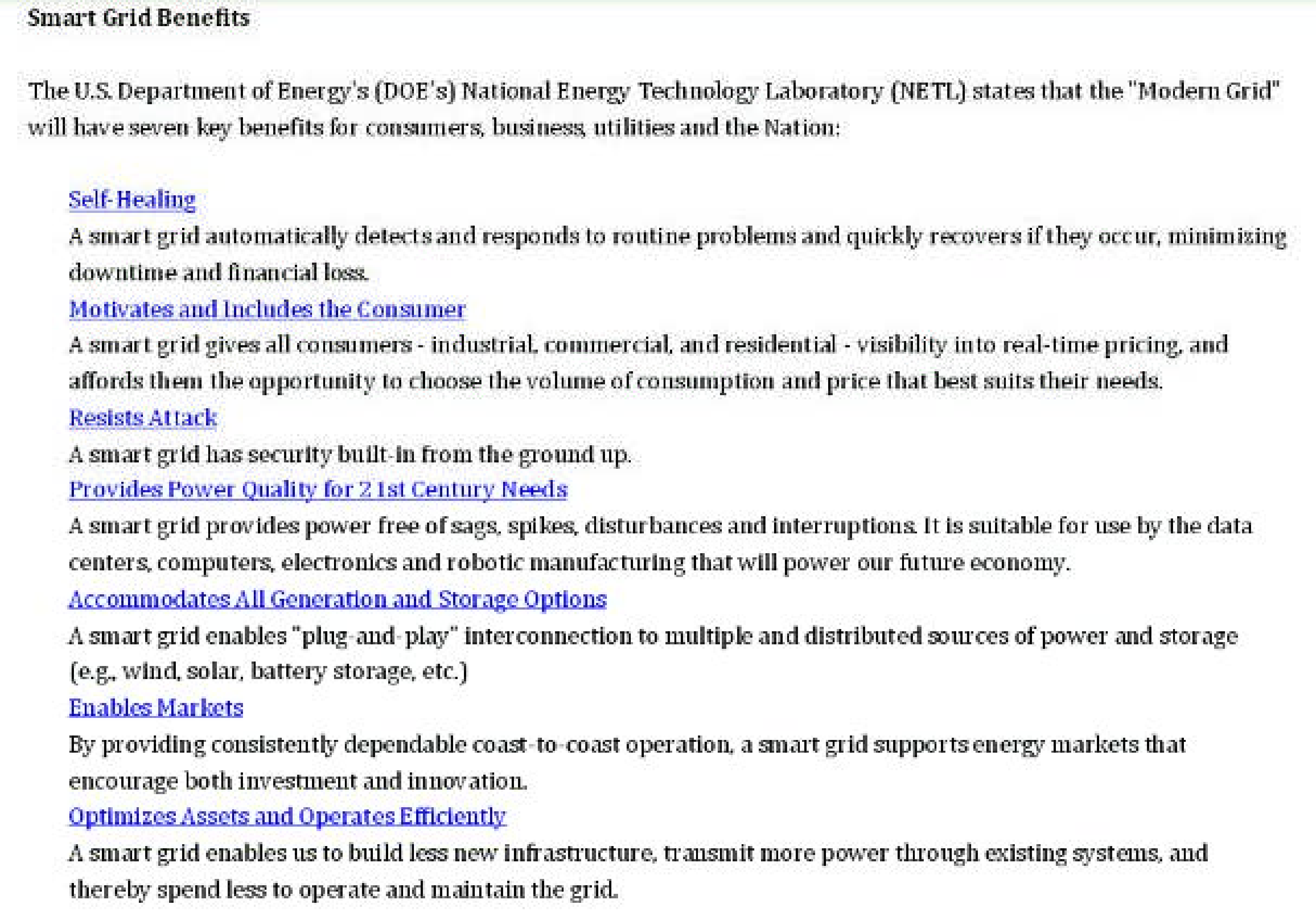


Figure 2-2: Smart Grid Components



Smart Grid Benefits

The U.S. Department of Energy's (DOE's) National Energy Technology Laboratory (NETL) states that the "Modern Grid" will have seven key benefits for consumers, business, utilities and the Nation:

Self-Healing
A smart grid automatically detects and responds to routine problems and quickly recovers if they occur, minimizing downtime and financial loss.

Motivates and Includes the Consumer
A smart grid gives all consumers - industrial, commercial, and residential - visibility into real-time pricing, and affords them the opportunity to choose the volume of consumption and price that best suits their needs.

Resists Attack
A smart grid has security built-in from the ground up.

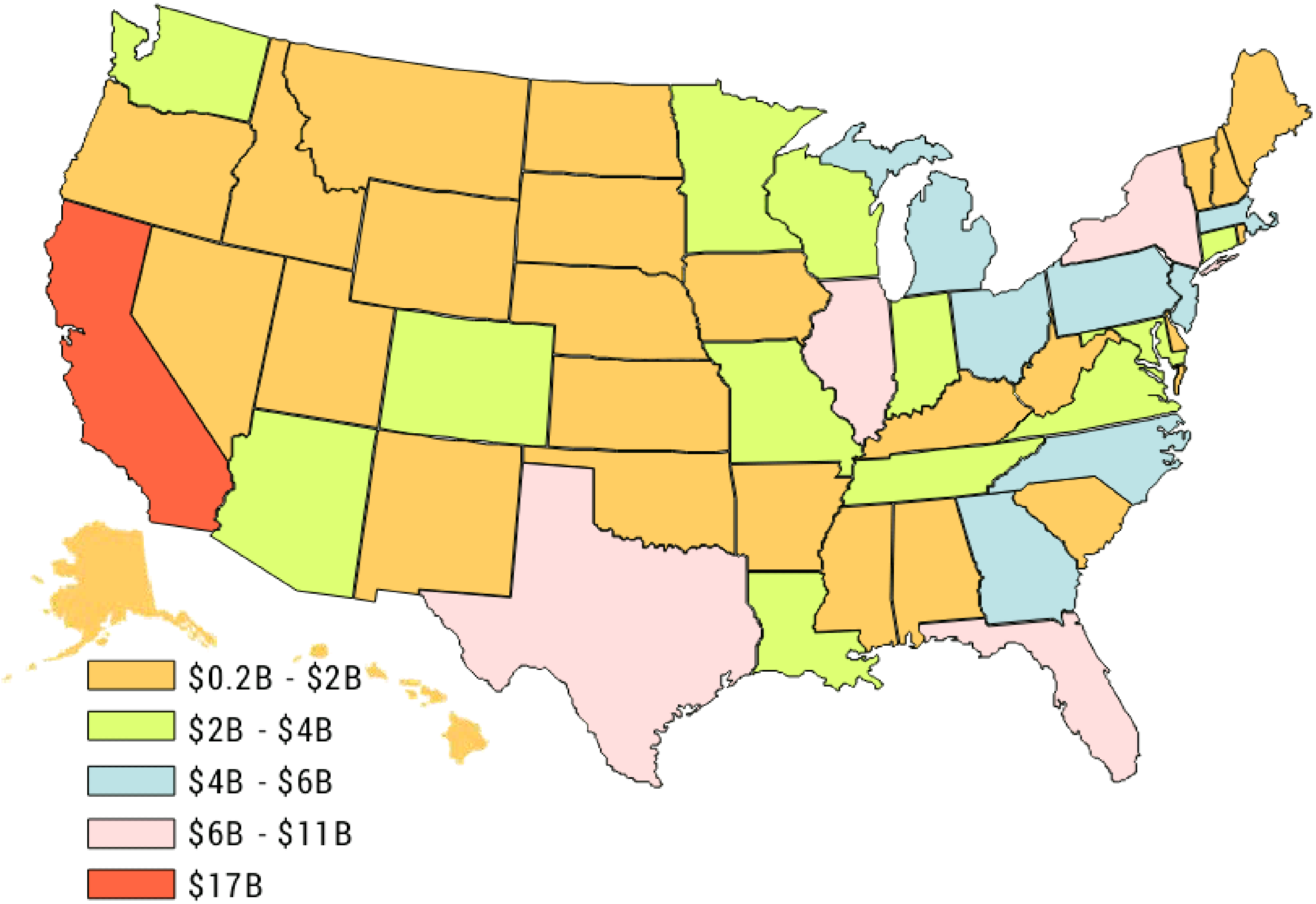
Provides Power Quality for 21st Century Needs
A smart grid provides power free of sags, spikes, disturbances and interruptions. It is suitable for use by the data centers, computers, electronics and robotic manufacturing that will power our future economy.

Accommodates All Generation and Storage Options
A smart grid enables "plug-and-play" interconnection to multiple and distributed sources of power and storage (e.g., wind, solar, battery storage, etc.)

Enables Markets
By providing consistently dependable coast-to-coast operation, a smart grid supports energy markets that encourage both investment and innovation.

Optimizes Assets and Operates Efficiently
A smart grid enables us to build less new infrastructure, transmit more power through existing systems, and thereby spend less to operate and maintain the grid.

Primen Study: Up to $135B annually for power interruptions



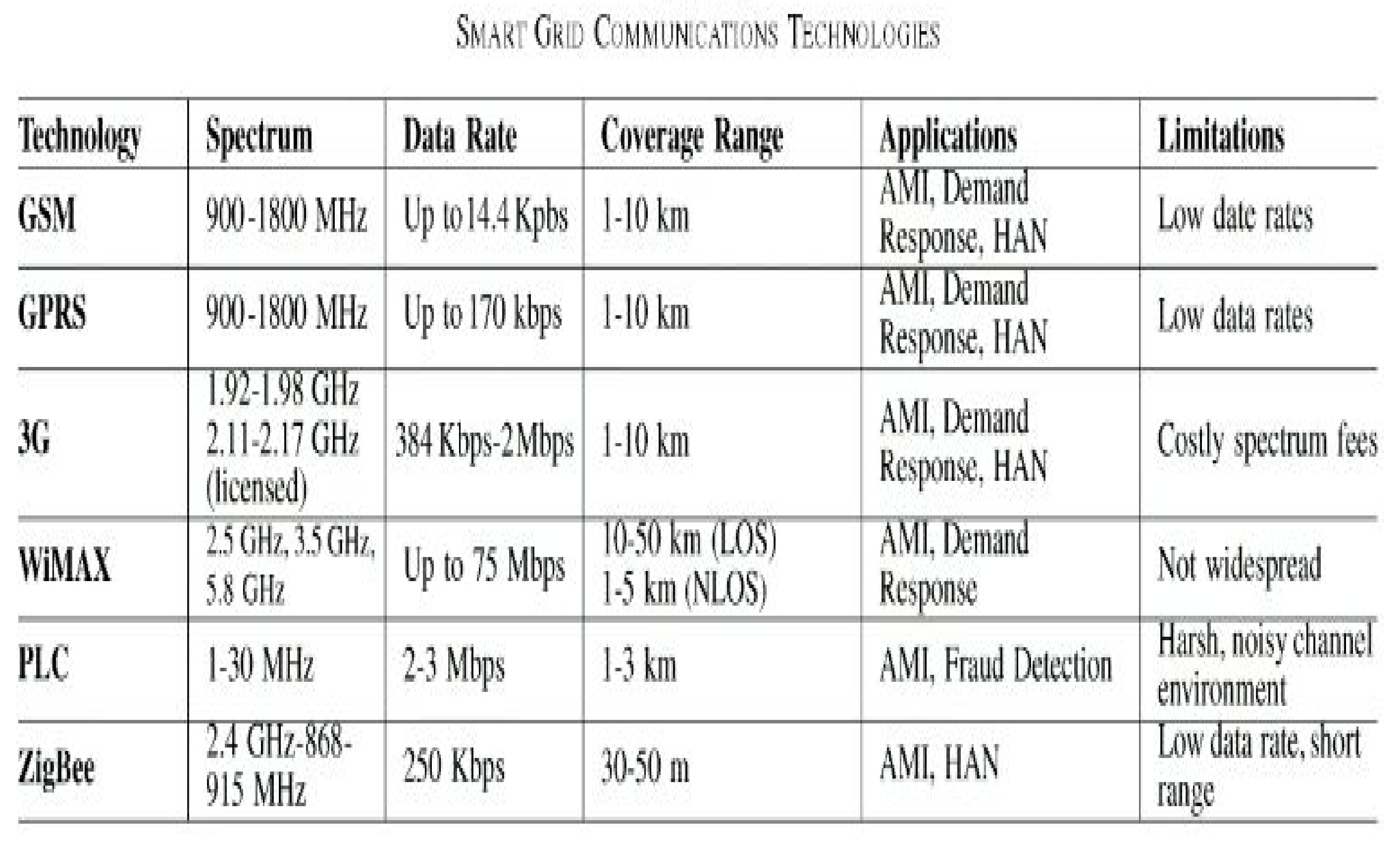
What is needed?

New algorithmic and computational methods are needed to address

(1) the high dimensionality of an optimization problem having a 40 year decision horizon, national geographical scope, multi-sector infrastructure representation, and high uncertainty;

(2) a need to provide solutions in terms of tradeoffs among multiple objectives; and

(3) the discrete nature of investment decisions.



SMART GRID COMMUNICATIONS TECHNOLOGIES

Technology	Spectrum	Data Rate	Coverage Range	Applications	Limitations
GSM	900-1800 MHz	Up to14.4 Kpbs	1-10 km	AMI, Demand Response, HAN	Low date rates
GPRS	900-1800 MHz	Up to 170 kbps	1-10 km	AMI, Demand Response, HAN	Low data rates
3G	1.92-1.98 GHz 2.11-2.17 GHz (licensed)	384 Kbps-2Mbps	1-10 km	AMI, Demand Response, HAN	Costly spectrum fees
WiMAX	2.5 GHz, 3.5 GHz, 5.8 GHz	Up to 75 Mbps	10-50 km (LOS) 1-5 km (NLOS)	AMI, Demand Response	Not widespread
PLC	1-30 MHz	2-3 Mbps	1-3 km	AMI, Fraud Detection	Harsh, noisy channel environment
ZigBee	2.4 GHz-868-915 MHz	250 Kbps	30-50 m	AMI, HAN	Low data rate, short range