The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 247750

High-Speed NB-PLC in Smart Grid Landscape – *State-of-the-art*

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Experience you can trust.

Content

- Smart Grid–Definitions/Concept
- Communications in Smart Grid Landscape
- Application Requirements
- PLC in Smart Grid
- PLC Realization within DLC+VIT4IP Projects

Smart Grid – A Term

SEVENTH FRAMEWORK PROGRAMME

"An automated, widely distributed energy delivery network characterized by a **two-way flow of electricity and information**, capable of monitoring and responding to changes in everything from power plants to customer preferences to individual appliances." [IEEE 802.15-09-0658-00]

Smart Grids are energy networks, which can achieve energy and cost efficiency through coordinated management using near-real-time bidirectional communications between:

- Network components (on the field),
- Generation,
- Power storage and
- Consumers

[Die Nationale Technologieplattform Smart Grids– Austria]

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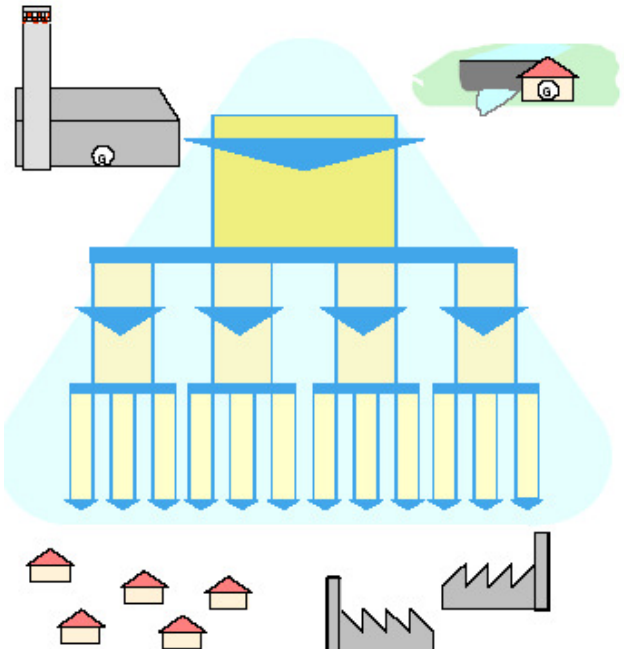
Smart Grid – A Concept

Present
Centralized Power Generation/Management
Passive Distribution Networks
Passive Customers

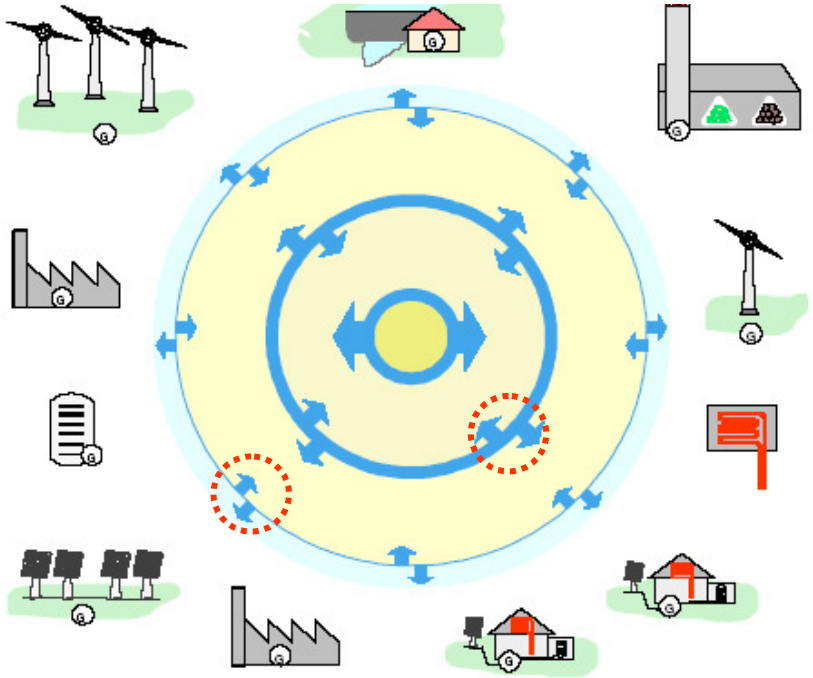
Future
Decentralized Generation/Management
Active Distribution Networks
Active Customers

Generation



Generation: centralized, far from consumer
→ Very high loss rate

Generation &Consumption

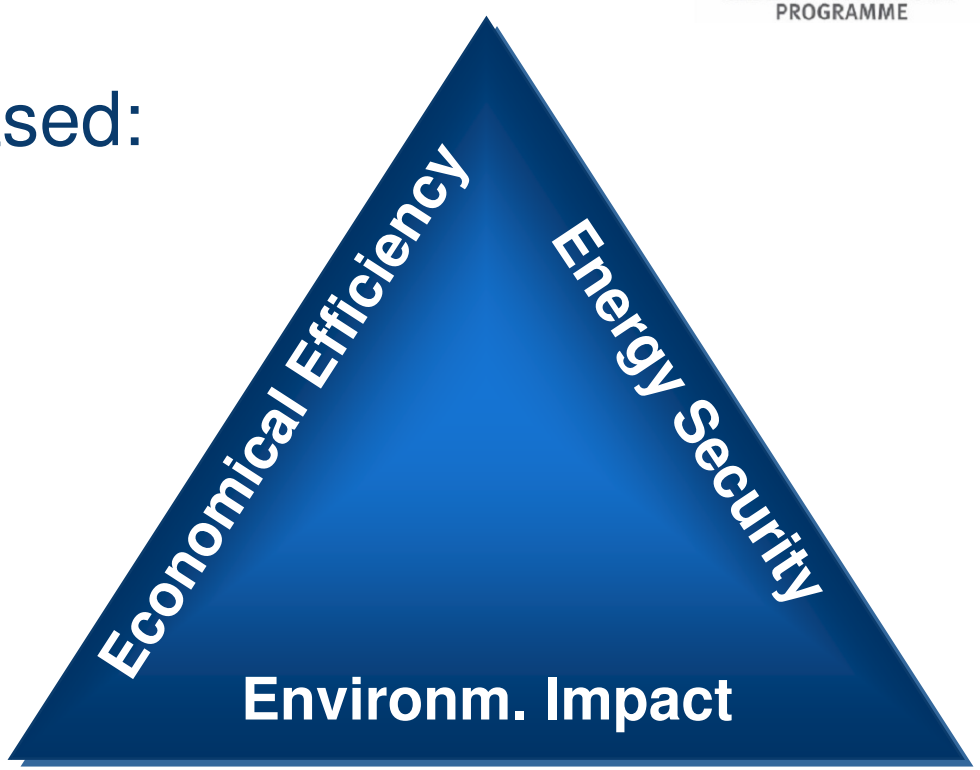


Generation &Consumption

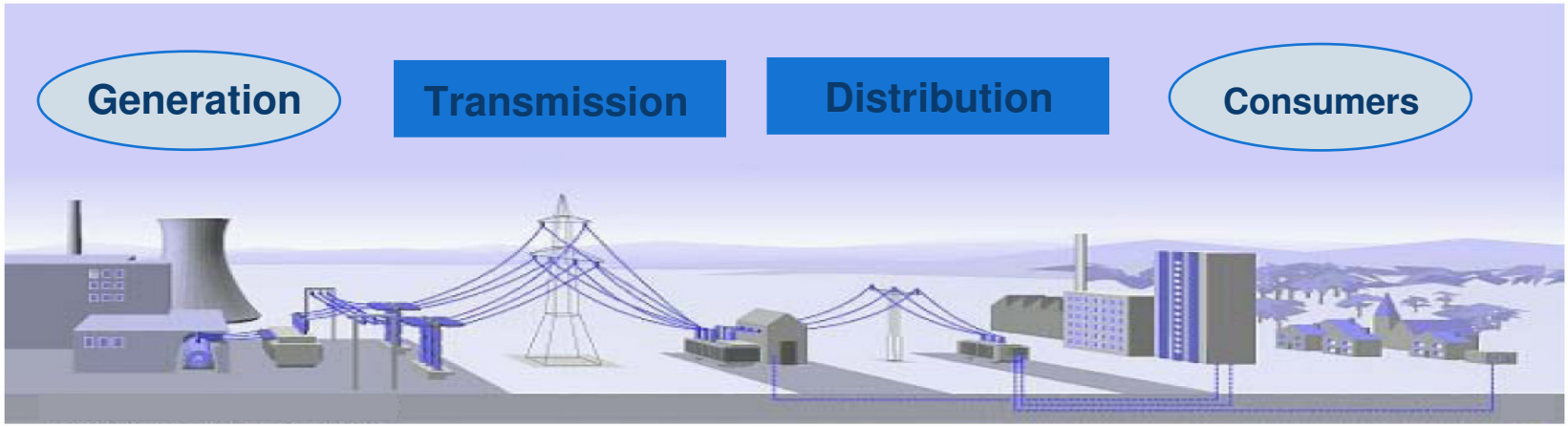
Which Benefits and Costs?

Future power with increased:

- Reliability
- Efficiency
- Security
- Safety
- Dynamic pricing
- Active customers (participation in energy market)
- Environmentally friendly, etc.



Smartness along Value Chain



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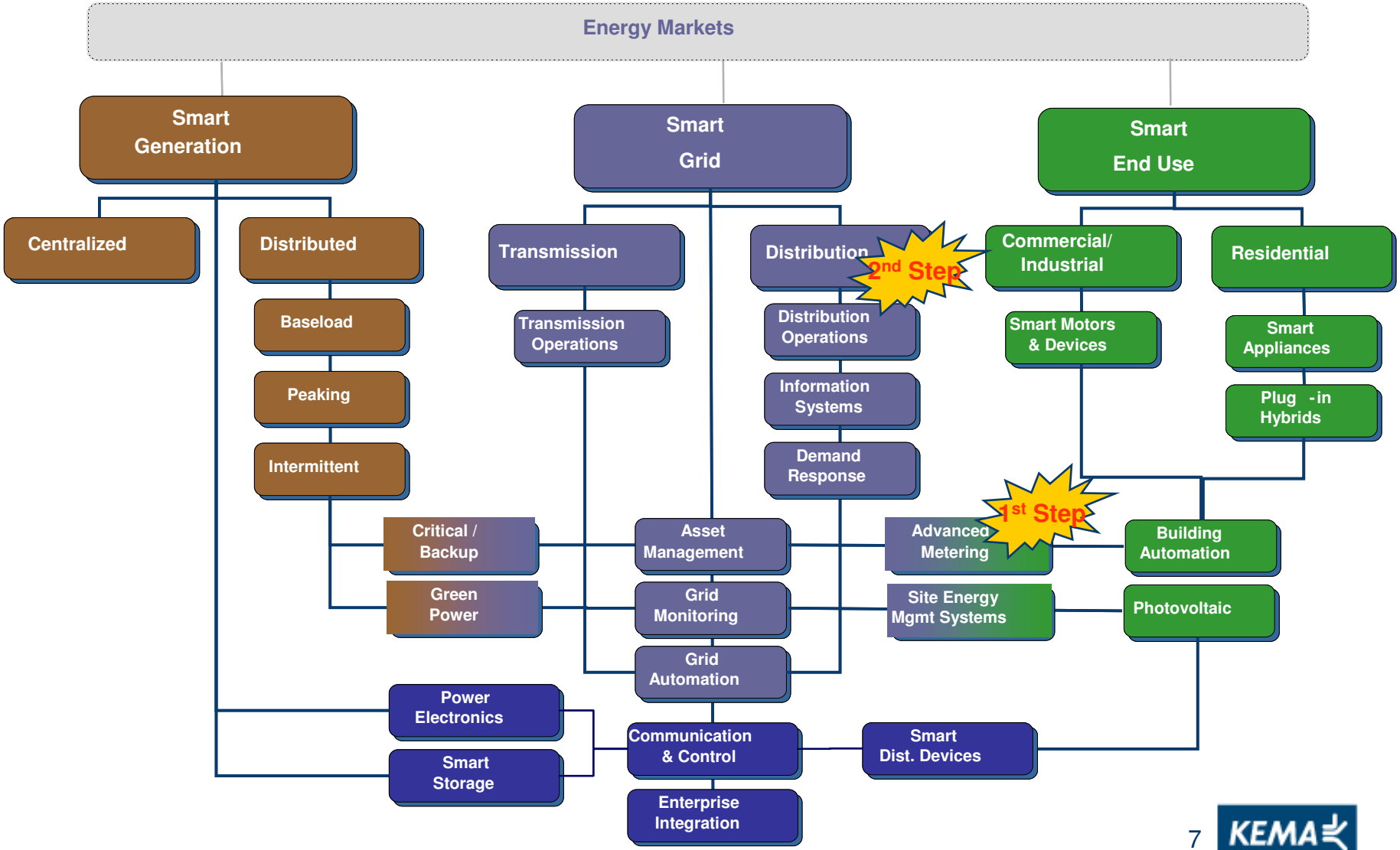
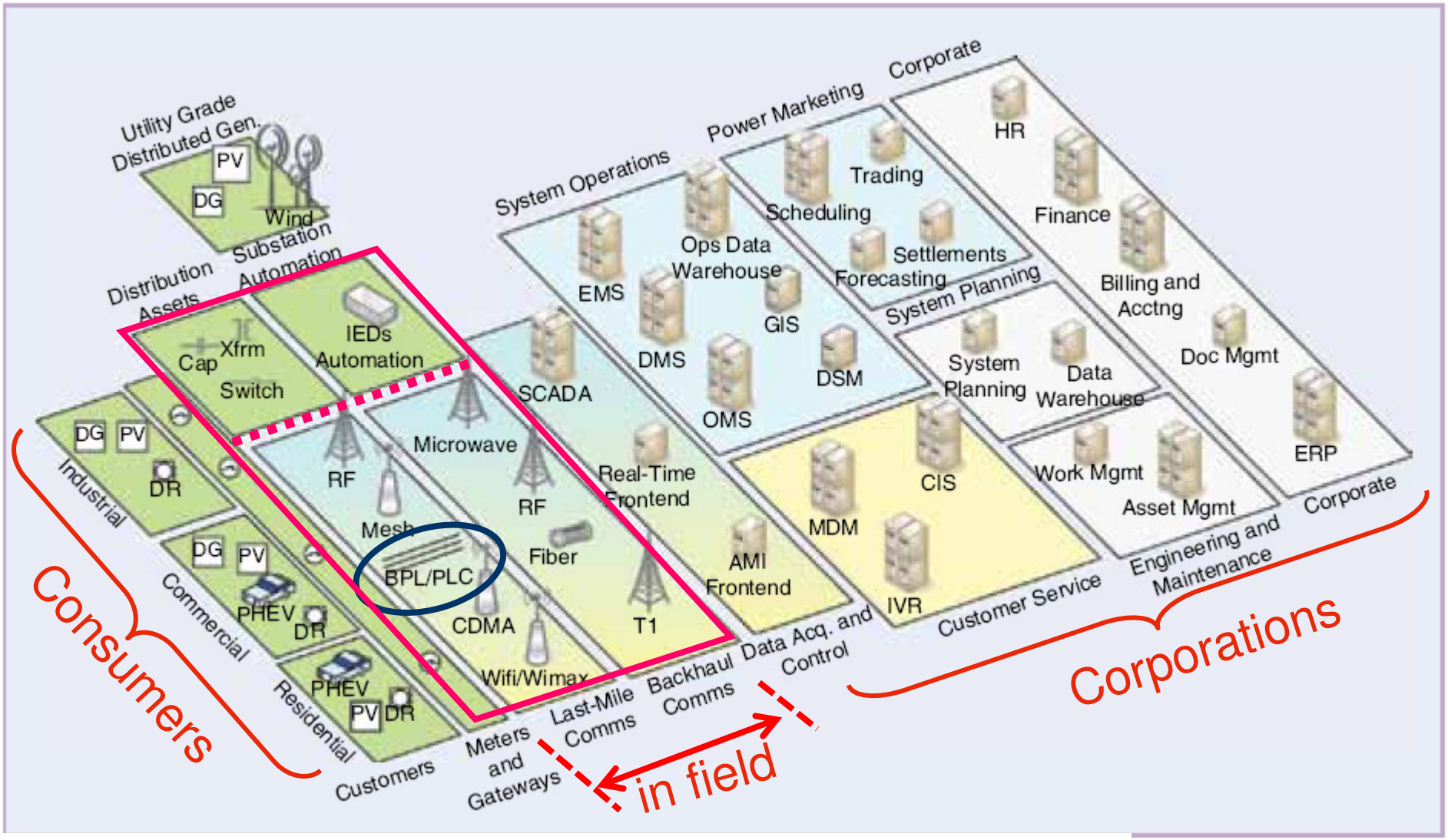


Smart Grid Architecture



View of utility information system impacted by SG strategies

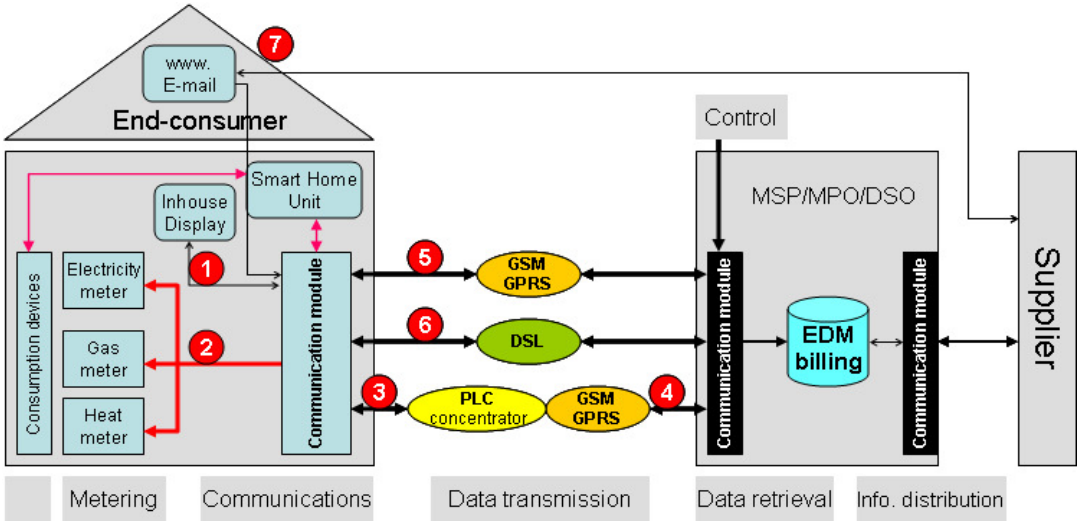
[Source: IEEE Power & Energy Magazine, 2010]

Current Status– Advantage PLC!

Communication Technology	DSL	PLC	GPRS
Small projects	1	4	4
Medium projects	3	7	2
Large projects	1	2	0
Total	**5**	**13**	**6**

Access technologies used in European Smart Metering projects

[Source: KEMA study, November 2009]



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Access technologies used in European Smart Metering projects

[Source: KEMA study, November 2009]

European Smart Metering Alliance (ESMA): "Annual Report on the Progress in Smart Metering 2009," February 2010

	Wireless	PLC
Cost of ownership	☹	☺
Reliability	☺	☹

PLC– Three Classes

	Low Data Rate Narrow Band	High Data Rate Narrow Band	Broad Band
Frequency Range	9 – 148.5 kHz	9 – 500 kHz A-Band 9-95 kHz B-Band 95-125 kHz BCD-Band 95-148.5 kHz other Bands	1.5 – 50 MHz
Data Rate	< 10 kbps	50 kbps < … < 1 Mbps	> 10 Mbps
Technology	FSK frequency shift keying BPSK binary phase shift keying FFH fast frequency hopping SFSK dual ch./ spread DCSK dif. chirp shift keying	OFDM orthogonal frequency division multiplex, MCM multi carrier modulation differential coding	MCM / COFDM, Bit loading
Forward Error Correction (FEC)	no or low	strong (for high reliability designed)	medium (for maximum throughput designed)
Applications	Automatic Meter Reading European Installation Bus Power Line Area Network	Airfield Lighting AGLAS, Energy Management Smart Grids & Metering AMR/AMM Automated Meter Reading / Management	Last mile Telecom, Internet, Voice over Internet Protocol (VoIP), High definition television (HDTV)
Companies, Organisations	Busch Jaeger, Echelon, Görlitz, Ytran, Renesas AMI Solution, Landis&Gyr	ADD Grup, iAd, Maxim, Prime (ADD, Current Group, Landis+Gyr, STMicroelectronics, Usyscom, ZIV, …)	Amperion, Current, DS2, Homeplug, Mitsubishi, OPERA, Panasonic, Spidcom

[Source: arivus~iAd, IPSLC-2009]

DLC+VIT4IP- Project Overview

- High-speed NB-PLC systems operates between 9 - 148.5 kHz (in EU)
- **DLC+VIT4IP** aims to prepare input to standardisation in order to widen this band to 9 - 500 kHz
- NB-PLC uses techniques including OFDM and Spread Spectrum modulation
- Data rate (100's of kbit/s to 1 Mbit/s).

DLC+VIT4IP- R&D

- Verification and Development of Channel Models, PHY Layers, Topology and Network models.
- Integration of PLC technology and energy applications using IP(v6) providing an ICT infrastructure for new applications such as AMR, DSM, DG, etc.
- Test of PLC technologies and systems in one or more field
- Contribution to standardisation including more precise Channel Models, Network Planning tools or Rules for Compliance Tests

DLC+VIT4IP- R&D

- Verification and Development of Channel Models, PHY Layers, Topology and Network models.

- Integration of PLC technology and energy applications using IP(v6) providing an ICT infrastructure for new applications such as AMR, DSM, DG, etc.

- Test of PLC technologies and systems in one or more

Phase 1	Phase 2	Phase 3
- Sate-of-the-art - Requirements spec. - System architecture	- Sim. implementation - Sys. Design/imp. - Field trial planning	- 2 x field trials - Verifications - Evaluations

DLC+VIT4IP- Application/Requirement

SEVENTH FRAMEWORK PROGRAMME

	bandwidth (kbit/s)	traffic type	Ma. Latency (s)	Max Jitter (ms)	BER	Max time of network recovery	Functional unit	Concentration	Main use
AMR	5,3 (1)	Periodic	0,5	NA	NA	1...2 hrs	per concentrator	300	LV
SCADA	1,8-9,6	Random	0,5	NA	1E-06 - 1E-14 (2)	1s	per concentrator	20	MV
Operational Telephony	8	Random	0,5	30	1E-03	15s	per call		MV
Video surveillance	15-128	Random	1	NA	1E-04	NA	per camera		MV
Load Management , DSM,DSI		Periodic	1	NA	NA	1s			MV,LV
Software download / upgrade firmware	32	Random	NA	NA	NA	NA	per concentrator	300	MV,LV
street lighting dimming & traffic control & maintenance	0,025	Random	300	NA		NA	group (32)	4	MV,LV

based on CIGRE (Conseil International des Grands Réseaux Electriques)

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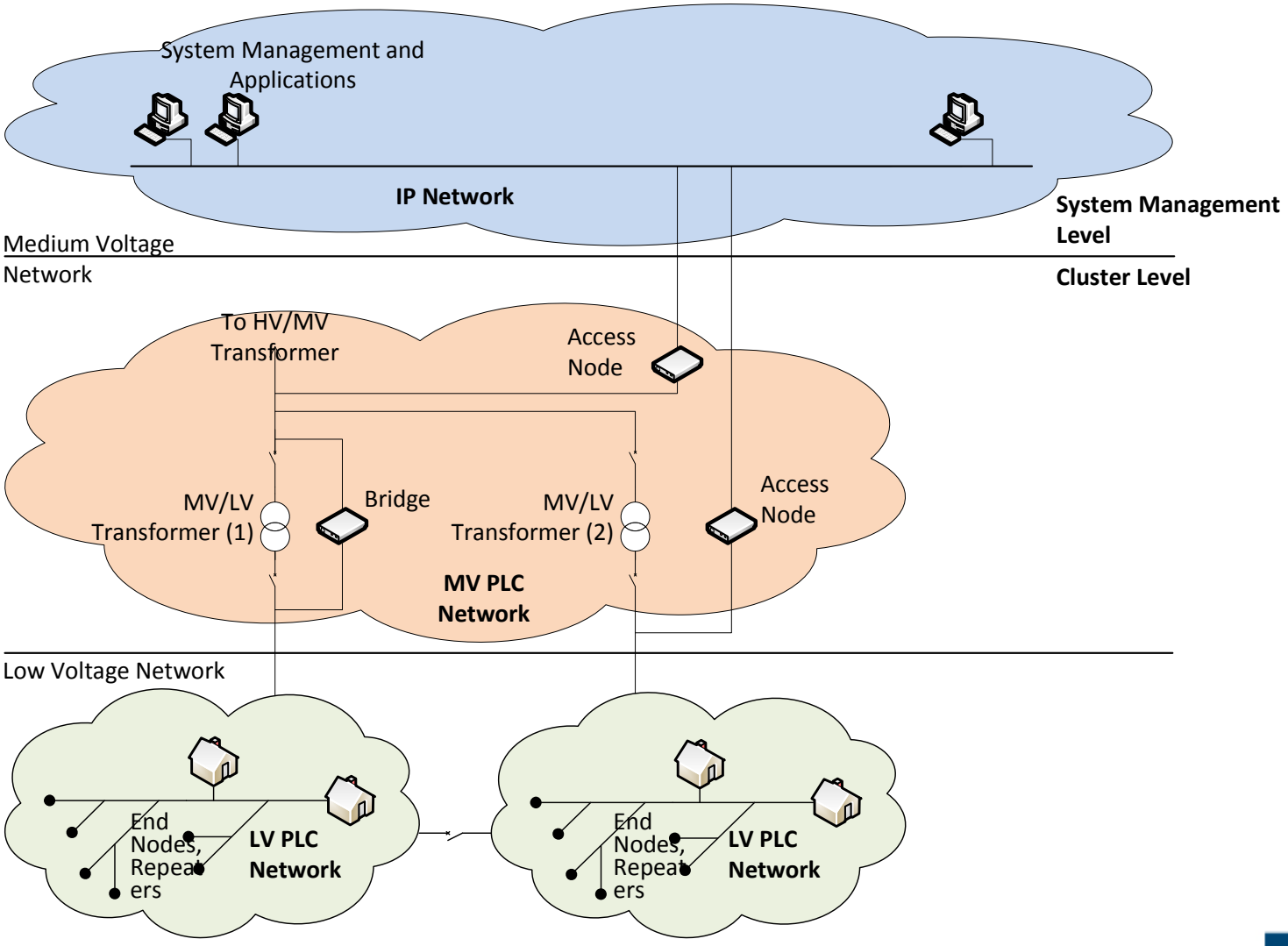
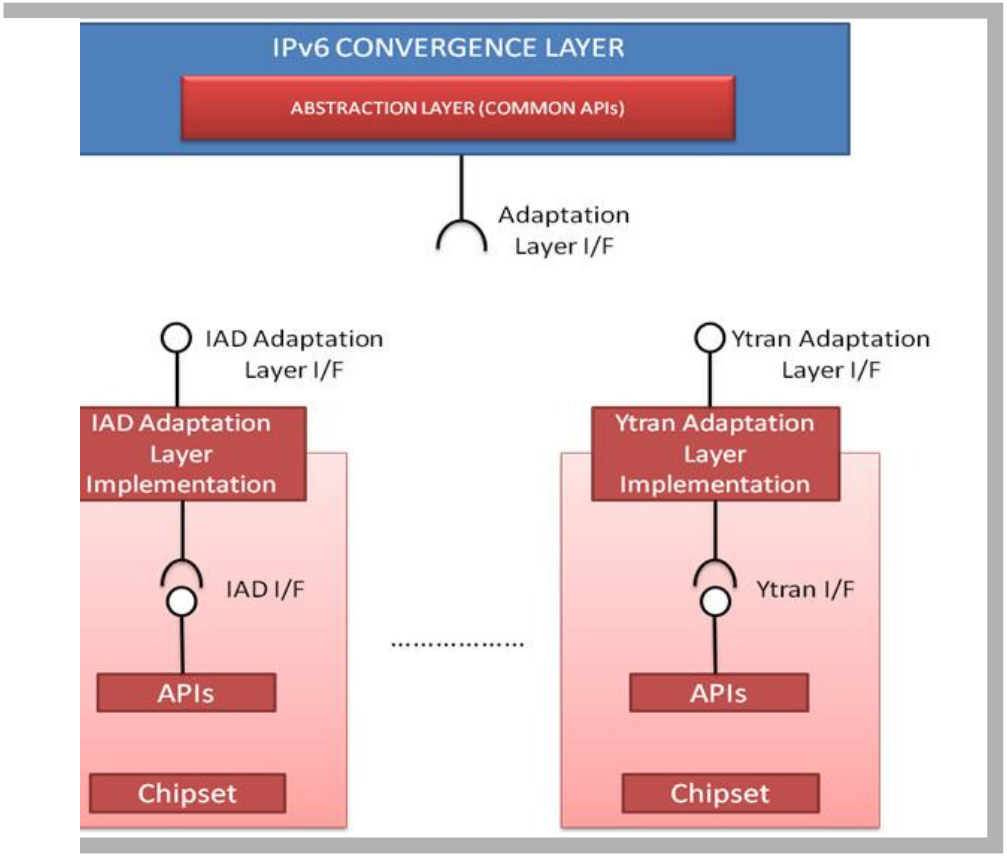
DLC+VIT4IP Concept



DLC+VIT4IP Concept

- IPv6 layer integration
- ROHC
- IP payload compression
- QoS management
- IPv4 support:
  - Tunneling Mechanism
  - Dual Stack Coexistence
  - Translation between IPv4-IPv6 Networks
- IPSec:
  - Data integrity
  - Authentication
  - Encryptation



Chip (MAC&PHY):
- iAd DLC 2000
- Yitran IT900

API: Application Programming Interface

Conclusions

- Main smart grid realizations are in distribution part
- Smart Grid: bi-directional flow of information and energy
- PLC is the wished solution of electric power utilities
- However, PLC is not the perfect solution
- Challenges: high bit rate, stable performance, standards, security

- DLC+VIT4IP project focuses on these challenges
  →more details www.dlc-vit4ip.org

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 247750

Thank you for your attention!

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