NBP RFI: Communications Requirements
Honeywell Responses

To Request for Information (RFI) from the Department of Energy on Implementing the National Broadband Plan by Studying the Communications Requirements of Electric Utilities To Inform Federal Smart Grid Policy

Honeywell is a world leader in automation and control solutions with decades of experience in energy management; today our energy efficiency products and services are found in over 150 million homes, over 10 million buildings and over 5,000 industrial facilities world-wide. We also have hundreds of utilities as our customers.

As a leading supplier of smart controls and with the benefit of our expertise from our large installed base mentioned above, *we respond to the DOE's questions specifically from the perspective of communications between the utility and the controls located on the customer premises*; we do not address the entire scope of smart grid communications (e.g., we do not consider communications necessary for phasor measurements, substation SCADA, protective relaying, etc.)

1) **What are the current and future communications needs of utilities, including for the deployment of new Smart Grid applications, and how are these needs being met?**

   There are 4 types of communications needs known today.

   1. Raw billing data (i.e., unrated meter readings corresponding to price periods)
   2. Real-time electricity consumption data
   3. Price data, demand response signals, etc.
   4. Summary data, statistical data, comparison data, etc.

   All utilities communicate raw billing data today in order to charge customers for their energy usage. This is handled via manual / drive-by meter reading or with smart meters communicating over AMI networks. Depending on the utility, some or all of the remaining items (2-4) are being done today.

The response to Question 4 addresses each of these communications needs and how they are being met.

2) **What are the basic requirements, such as security, bandwidth, reliability, coverage, latency, and backup, for smart grid communications and electric utility communications systems in general— today and tomorrow? How do these requirements impact the utilities' communication needs?**

See response to Question 4.

3) **What are other additional considerations (e.g. terrain, foliage, customer density and size of service territory)?**

Not answered.

4) **What are the use cases for various smart grid applications and other communications needs?**

The need for communications arises whenever there is a need to transfer data; several different categories of data (use cases) are involved in the Smart Grid. These data categories place dramatically different requirements on the Smart Grid communications infrastructure. Let us start by splitting the data into categories.

a. Raw billing data. To implement any kind of variable pricing, the utility needs to take a meter reading every time the price changes, so that the utility can rate consumption during each period based on the corresponding price and calculate the customer's bill.
b. Real-time electricity consumption data. Modern smart meters can provide consumption data at very fine granularity (e.g., once a minute or more frequently) and in near real time (less than 10 seconds delay). Such detailed data can allow users to track their electricity consumption through an in-home display, understand the impact of their actions through instant feedback and modify their behavior to achieve savings (reduce consumption or shift it to off-peak hours). The information can also be fed into controllers / home energy managers that can take decisions automatically based on preferences programmed by the consumer, allowing the consumer to "set and forget."

c. Price data, demand response signals, etc. This data typically originates at a utility's back-office and needs to be delivered to many end-users.
d. Summary data, statistical data, comparison data, etc. For example, users may see historical trends in their consumption patterns, comparisons with their peers / neighbors, data normalized using factors such as weather, etc.

For many categories of Smart Grid data, the smart meter is not the most appropriate communications medium; existing commercial wired and wireless communications infrastructure is capable of handling the transmission of such Smart Grid data even better than existing or planned utility communications infrastructure (including smart meters). From a public policy standpoint, ratepayers should not be asked to shoulder the cost of upgrading utility owned and operated communications infrastructure when viable commercial alternatives are already deployed.

Raw billing data (meter readings taken at the end of each price period – a few times a day – for billing purposes) should be transmitted from the meter straight to the utility's back-office. This communication does not have to be real-time and does not require significant bandwidth (measurements are needed only a couple of times per day). AMI networks were designed exactly for this purpose. After consumption is rated and the bill is calculated (at the end of the month or on an ongoing basis), it can be presented to the user through an Internet customer care portal, just like most service companies do today. The user does not need access to the raw billing data in real time, since the real-time consumption data has much finer granularity and, therefore, subsumes the raw billing data.

Real-time consumption data originates at the meter and needs to be presented to the user (e.g., through an in-home display) or to a user's control device(s) that can act locally to manage energy consuming devices and appliances, adjust set points, etc. Since this real-time data is voluminous and of use only to the customer, it should be transmitted directly from the meter to the customer premises; there is no reason to transmit this data over the AMI network. Thus, the meter should have an appropriate open standard interface to allow meter reading from within the customer premises.

Price data, demand response signals, etc. originate at the utility's back office and are unrelated to the meter (neither originate at nor are intended for the meter), so they can be carried over multiple communications paths. There are no valid technical, security, or policy arguments that would force these signals to be carried solely on utility owned and operated communications infrastructure.

Today, practically all of the residential demand response programs use some form of an existing broadcast medium, e.g., a VHF or paging network. In the future, such data can be sent over the Internet through any communications medium – broadband (cable, DSL, fiber, etc.), cellular, WiFi, WiMAX; using the Internet will allow for two-way communication (e.g., acknowledgements) and also enable future applications, such as PHEV charging, that pose demands for higher bandwidth and lower latency. AMI networks were not designed for this purpose and will be unable to provide either the bandwidth or the latency required for these applications on a broad scale. In fact, today many AMI networks have intermittent connectivity to the utility: data is aggregated over mesh networks to aggregator nodes that periodically establish a connection (e.g., over cellular) with the utility's back-office and upload the aggregated data. Utilities may initially try to use their AMI networks to distribute price data and demand response signals, at least in a one-way fashion. If this happens, it will be critical to establish interfaces that will allow migration of these applications to different networks in the future (e.g., Internet, evolved version of the utility network).

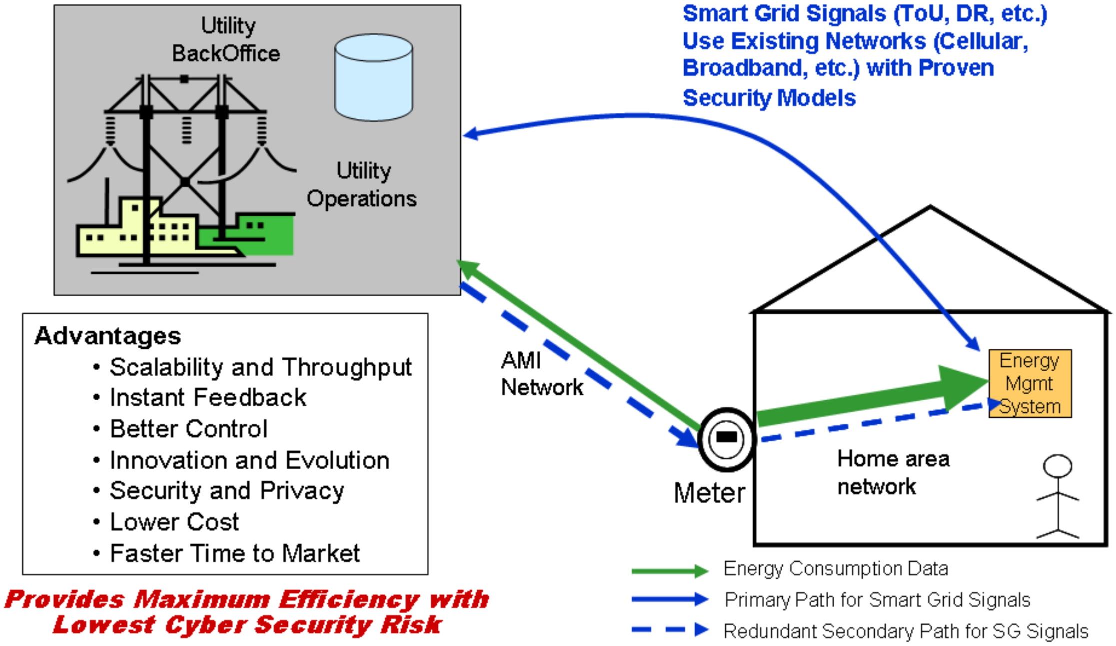
Finally, with respect to the summary / comparison data, there is again no need to involve the meter. Such data can be provided from a website over the Internet, just like bill presentment.

5) What are the technology options for smart grid and other utility communications?

There are numerous technology options for smart grid communications. As communications technologies improve, even more options are likely to emerge in the future and some of today's technologies are likely to become obsolete. Thus, it is essential that the smart grid ride the communications technology curve and benefit from the billions of dollars invested in the telecommunications sector. To achieve this, the smart grid needs to utilize general purpose communications networks to the maximum degree possible. Communications technologies developed and deployed specifically for utilities are likely to fall behind. The response to Question 6 proposes an optimal architecture that facilitates network evolution and offers many additional benefits.

6) What are the recommendations for meeting current and future utility requirements, based on each use case, the technology options that are available, and other considerations?

The proposed optimal architecture is shown in the figure below.



The real-time electricity consumption data goes directly from the meter to the house (green arrow pointing to the right, thicker to indicate large data volume) using a single, open and standardized communications architecture between the meter and the HAN. This allows maximum flexibility for the consumer. To assuage privacy concerns, the interface should be one-way, from the meter to the HAN. The real-time consumption data is received by an in-home display or the energy management system within the house (this can be a stand-alone device or can be embedded in another device).

The raw billing data (interval reading whenever price changes) goes from the meter to the utility back-office over the AMI network (green arrow pointing to the left).

Price data, demand response signals, etc. go from the utility back-office to the customer premises over existing infrastructure (broadband, cellular, etc.); this is shown with the solid blue arrows. As a secondary mechanism, the utility could also use its AMI network to send DR (demand response) signals; this path is shown with the dashed blue arrows. This secondary mechanism can be used for higher overall availability or in situations where there is no coverage by existing infrastructure.

The price data, demand response signals, etc. are received by the home energy management system, where the energy services interface (ESI) is hosted. As mentioned above, this can be a stand-alone device or can be embedded in a multitude of energy using devices. The architecture should be flexible enough to allow an energy management system, if present, to control these devices. For on/off devices like pool pumps and electric water heaters that do not contain user interfaces of sufficient capability, the preferred embodiment is a home energy manager that provides the main point of control and interaction. The home energy manager will also forward price or DR signals to smart thermostats (which manage HVAC devices) and other appliances (e.g., refrigerators) that are not simply on/off and include logic to make scheduling and consumption decisions based on this information.

The architecture proposed above provides multiple benefits:
Scalability and high throughput. There is no need for a centralized system that would become a bottleneck. The bulk of the data (real-time usage) is transmitted directly to the customer premises over a local connection.
Instant feedback. Users can see the impact of their actions on power consumption immediately, understand their energy usage and modify their behavior. It would be very difficult to achieve the same effect with data from the previous day. Do people remember what they were doing at 6:15 PM the previous day?
Better control. The availability of real-time usage data can help the control algorithms implemented in home energy management systems make optimal energy consumption decisions and save money for consumers.
Innovation and evolution. The HAN devices and the utility side can evolve independently of each other. The market for HAN devices can generate innovation.
Security and privacy. The real-time usage data goes to the consumer, who owns it; the user's privacy is not compromised. This data will be encrypted, but even if this data were transmitted in the clear, the only people who would be able to "eavesdrop" on one's consumption data in the local home area network would be one's neighbors, who can see that data today, anyway (they can just read the meter mounted on the external wall). The proposed solution also offers higher security: if all the data were centralized in a location in the cloud, it would be susceptible to remote attacks and a compromise of such a central location could lead to loss of data from a large number of homes, which could in turn allow destabilization of the grid if all those homes were affected by the attacker.
Lower cost. Uses existing infrastructure for communicating price data, DR signals, etc. and obviates the need for additional telecommunications networks. Avoids large centralized IT installations. Uses off-the-shelf short range communication technologies.
Faster time to market. The Smart Grid can reach consumers' homes today, so that consumers do not have to wait for additional infrastructure to be deployed; consumers can start benefiting immediately from understanding their consumption and saving money through energy efficiency and demand response

7) To what extent can existing commercial networks satisfy the utilities' communications needs?

Bill presentment, price data / demand response signals and summary / comparison data are best delivered over the Internet; there is no need to use the meter as a gateway to a customer premises area network for these items. Since the Internet today (collectively, broadband, cellular, municipal WiFi, etc.) has much higher market penetration than smart meters and AMI networks, using the Internet will enable the shortest time to market for the deployment of the Smart Grid and will allow consumers to start reaping the benefits as quickly as possible. With the administration's emphasis on universal broadband coverage, the situation will increasingly favor the Internet over AMI networks. Furthermore, this is the most economical path for the deployment of the Smart Grid; the nation has already paid for the deployment of several networks (by phone companies, cable companies, cellular companies et al.), so we might as well use them and avoid saddling rate payers with the capital cost of deploying additional, unnecessary communications infrastructure. The savings can be applied towards deploying technologies (e.g., in-home displays, smart appliances, smart thermostats) that will actually take energy conservation measures (efficiency, demand response) and provide immediate economic benefits. Finally, this approach is future proof: if new communication technologies emerge or if utilities deploy new networks, consumers will still be able to connect, as long as the new networks provide an IP protocol interface; IP has simply withstood the test of time for the last four decades.

One of the arguments often voiced against using the Internet and in favor of using utility-owned communications infrastructure for the Smart Grid is that Internet coverage, although very high, is not 100%. Let us look at the numbers: broadband access is now available to over 92% of the U.S. population and this number will rise with the administration's broadband deployment plans; cellular coverage is available to 99% of the U.S. population. In contrast, only a single-digit percentage of households have an AMI meter and the number of those meters that are actually connected to a fully functioning AMI network is even lower. While these AMI numbers will grow rapidly, it will still take years (if not decades) and tens of billions of dollars until the deployment of smart meters reaches the penetration level of the commercially available communications infrastructure. Furthermore, the same reasons (unfavorable cost-benefit analysis) that have prevented broadband and cellular from reaching 100% coverage will probably also prevent AMI networks from reaching 100% coverage.

Even if the coverage of the commercially available communications infrastructure remained frozen at today’s levels and even if AMI networks eventually achieved 100% coverage, is it worth delaying the deployment of the Smart Grid for years while waiting for AMI network coverage to ramp up? Are the benefits from the participation of the last 1% (or less) of households in the Smart Grid worth delaying the entire nation? And if utilities insist on 100% coverage, why not start deployment of AMI networks from the 1% that has no other communications coverage (i.e., neither cellular nor broadband) and use the existing infrastructure for the remainder of the country?

Given all of the above, the argument that AMI networks need to be deployed everywhere because of coverage reasons is specious. The AMI network can be used as a last resort for communications. If this is ever the case, the meter should be used as a simple data router that passes uninterpreted data back and forth; the meter should not have any intelligence to process any of the data it passes through. If the meter had such intelligence, it would make network evolution difficult and would not be a future-proof solution.

The use of the Internet as suggested above will also make the Smart Grid future-proof with respect to emerging applications, such as PHEV charging, that pose demands for higher bandwidth and lower latency. With respect to security, long-proven and well-understood IP security technologies can be employed for both current and future applications.

Some people go as far as suggesting that even the real-time consumption data can be delivered over the general Internet (rather than directly from the meter to the customer premises). This suggestion will lead to a suboptimal architecture and will waste resources because it implies that the real-time data must somehow be uploaded from the meter to a utility database server and then sent back down to the customer premises through the Internet. How will the real-time data get to the database server? Over the AMI network? We have already discussed above the bandwidth and latency limitations of these networks. Furthermore, this approach would be unnecessarily costly: it is much more expensive to create a new network infrastructure and a new data processing infrastructure that would process all these millions of transactions (meter reads) per second than to simply provide a standardized interface on the meter that would allow the data to be read from the customer premises. This interface can (and should) use the IP protocol, so that the meter looks like an IP device.

8) **What, if any, improvements to the commercial networks can be made to satisfy the utilities' communications needs?**

No improvements are required. Existing commercial networks are very robust and are used today for many applications that demand high performance, privacy and security (e.g., video transmission, internet banking, on-line purchases, tax return filing).

9) **As the Smart Grid grows and expands, how do the electric utilities foresee their communications requirements as growing and adapting along with the expansion of Smart Grid applications?**

Smart Grid applications will grow very rapidly in ways that we cannot even imagine today. The utility communication infrastructure must grow and adapt to this expansion. This can be costly for the utility and the ratepayers if not properly addressed upfront with the right architecture. Utilities must take maximum advantage of general communications infrastructure (i.e., broadband networks). The broadband networks will continue to evolve and support the expansion of the Smart Grid in scale and scope without requiring major R&D investments from the Smart Grid sector.