Technology Type		Fiber-ONLY		Copper-ONLY - NOTE: Copper-ONLY can also be used in the Fiber/Copper hybrid case	Fiber/Copper hybrid	
		FTTP/H (Fiber To The Premises/Home)		DSL Rings - Genesis Technical Systems	FTTN (Fiber To The Node)	FTTC (Fiber To The Curb)
Comparison	Description	xPON (Passive Optical Network) A single optical fiber runs all the way from the CO to the neighbourhood where it 'passes' each house in that neighbourhood. When the customer requests service a technician comes out to 'connect' the house to the single fiber strand via an optical splitter or coupler. In some cases Verizon removed the copper wires from houses where they provided xPON services so that the customer had no fall-back option.	Optical Ethernet (often called Point-to-Point) A 'cable' of fibers is routed from the CO to the neighbourhood. There are sufficient individual fibers in the 'cable' (or 'bundle') so that there can be a single fiber routed to each house in that neighbourhood if every house requests service. When service is requested by the customer a technician comes out to physically route their individual fiber from the 'cable' to the customer's house. This is similar to the current copper network architecture except using fiber.	The 24-to-50-pair cables from the Pedestal to the CO are logically bonded together to create a single communications link. This can be done as a Plain Old Telephone Service (POTS) overlay so that Emergency voice services are not impacted when the power fails. From the pedestal to the home a copper ring is created by connecting home-to-home in the pedestal using a passive cross-connect matrix (which enables adding & removing houses from the ring remotely) and using 2-pairs/home. Home Gateway devices in each home terminate (traffic can be added, removed, passed through, or drop-and-continue multicast) and regenerate the signal on the existing copper lines so that the VDSL2 transmission curve re-starts at each home. This enables very high bandwidth over the existing copper telephone wires.	Fiber is routed from the CO to the big cabinet (typically more than 6 feet across and 4 feet high) - often green in colour. A Remote DSLAM is installed in this cabinet along with the big wiring patch panel. The fiber link basically replaces the big 1000-pair cable coming from the CO thereby reducing the distance that the DSLAM has to transmit. This makes the resultant DSL-based bandwidth higher as the transmission distance has been reduced by the distance from the Cabinet to the CO. The link from the cabinet to the house is still the existing copper plant. Often VDSL2 is the DSL technology of choice from the Cabinet to the home.	Fiber is routed from the CO to the Pedestal. This bypasses the 1000-pair copper cables from the CO to the Cabinet and the 24-to-50-pair cables from the Cabinet to the Pedestal. A mini-Remote DSLAM is installed in the pedestal. The original pedestal - basically a small wiring patch panel - is replaced with a new enclosure that has mains power and batteries. This is an outside plant, environmentally hardened enclosure.
Economic Criteria						
Cost Efficiency	How well does the capital expenditure scale with adding/removing customers? What is the potential for stranded capital investment?	Highly inflexible physical architecture. Fiber is deployed in the hopes that customers will buy the services offered over that fiber. A neighbourhood has a single fiber deployed to it, then a truck roll has to occur for each customer. High potential for stranded capital investment.	Highly inflexible physical architecture. Fiber is deployed in the hopes that customers will buy the services offered over that fiber. A neighbourhood has the fiber 'cable' deployed to it, then a truck roll has to occur for each customer. Highest potential for stranded capital investment.	Once installed there are no physical changes that need to occur to add or remove served customers. The potential for stranded capital investment is comparitively non-existent.	Minimal customer impact other than seeing higher bandwidth over their DSL connection. May need a new modem to achieve the higher rates. However, least return for Telcos in that all it offers is increased bandwidth of 2-4x non-FTTN systems	Not as cost efficient as FTTN. High initial costs to supply a neighbourhood with the risk of low take rate on premium services. Higher bandwidth is the only advantage of this approach over straight DSL or FTTN.
Deployment Time	Once the decision to deploy is made, what are the various logistical obstacles to providing service to a selected area	Very long as new fiber cable must be trenched or hung from poles, legal Rights-of-Way must be secured and batteries installed in homes for cases where the power fails.	Very long as new fiber cable must be trenched or hung from poles, legal Rights-of-Way must be secured and batteries installed in homes for cases where the power fails.	Very fast - it is estimated that a single technician can deploy DSLR to 4-5 houses, including the pedestal upgrade, in a single day.	Faster deployment than FTTP/H but still requires significant amounts of fiber to be deployed as well as mains power to the cabinet, a new cabinet with batteries & Heating, Ventillation, & Air Conditioning (HVAC) systems as well as the remote DSLAM.	Much longer than FTTN but not as long as FTTP/H. Needs mains power to terminate the optical signal at the pedestal which generally implies batteries and HVAC systems as well.
Deployment Model	Does the system have to be deployed before the customer can be served or can the customer be added to the service later on in an efficient manner? Describes the level of risk to deployment capital used.	“Build it and they will come” - highest level of capital risk in telecom networks today.	“Build it and they will come” - highest level of capital risk in telecom networks today.	“Pay as you grow” - lowest level of capital risk in this spreadsheet. Capital is not risked until the customer agrees to pay for the service.	“Build it and they will come” - Third highest level of capital risk in this spreadsheet.	“Build it and they will come” - Second highest level of capital risk in this spreadsheet.
Technical Criteria						

Bandwidth	What are the announced rates of traffic delivery in Megabits per second (Mb/s)	Set bandwidth slice. Current advertised options include: 5Mb/s, 15Mb/s, 30Mb/s, and up to 100Mb/s in some cases though this is configurable by the telco up to the split ratio of generally 1:32 (i.e.: one fiber is shared with 32 homes)	Each house gets a dedicated optical fiber so whatever the end points can support is what can theoretically be offered. 1Gb/s is being offered over this type of architecture in some areas of some Asian countries (e.g.: South Korea, Tiawan, Japan, Singapore).	Up to 400 Mb/s combined upstream & downstream (2x VDSL2 maximum bandwidth) depending on the number of upstream pairs bonded and distance the pedestal is from the CO.	Typical maximum of 20 Mb/s unless 2-pair bonding from the cabinet is used, which would provide up to 40 Mb/s depending on the distance between the cabinet and the home and the DSL bandplan used.	Typical maximum of 80 Mb/s for a single pair or 150+ Mb/s for 2-pair bonded. Depending on frequency band plan, 200 Mb/s symmetric (400 Mb/s combined) could be achieved with VDSL2's 30a bandplan.
Power	How is power provided to the system?	Downstream power supplied by CO, upstream power supplied by consumer mains.	Downstream power supplied by CO, upstream power supplied by consumer mains.	All power to the pedestal is supplied by the CO in urban situations. Mains power required for rural applications. Lifeline capability provided by POTS support.	Mains power has to be supplied to the cabinet, which generally has only a passive wiring patch panel in it today. The household modem is powered by the household mains.	Mains power required to terminate the optical signal which also suggests batteries and a larger enclosure than the standard pedestal.
Lifeline Support	How does the system provide lifeline support when the power fails? What if a natural disaster (Katrina, ice storm) knocks out power for an extended period where mobiles will not be able to be charged from the home?	Lifeline capability provided by batteries in CPE. Typical battery life is 8 hours or less.	Lifeline capability provided by batteries in CPE. Typical battery life is 8 hours or less.	DSL Rings can be implemented as a frequency overlay on top of POTS. POTS has been shown to survive weeks without power as long as the CO power is maintained.	Generally no battery back-up for power failure situations.	Generally no battery back-up for power failure situations.
Sharing	All network bandwidth is shared at some point. What is the mechanism for sharing the bandwidth?	PON technology broadcasts all downstream data to all houses so all downstream bandwidth is shared. Upstream bandwidth is dynamically assigned timeslots based on various parameters such as transmit queue fill levels.	Sharing happens once the traffic reaches the CO in the larger network 'cloud'.	Each DSL Ring-based Home Gateway is an Add Drop Multiplexer (ADM). All ring bandwidth is available at each node subject to QoS and SLA provisions.	The copper portion of the link between the cabinet & the home is not shared but the fiber link from the cabinet to the CO is shared between however many houses are served by the cabinet (typical numbers would be in the several hundreds).	The copper portion of the link between the pedestal & the home is not shared but the fiber link from the pedestal to the CO is shared between however many houses are served by the pedestal (typical numbers would be in the 3-16 range).
Security	What are the traffic security considerations in each system?	Encryption is used to protect each user's data. Otherwise it is a bus model and everyone can 'see' everyone else's encrypted traffic.	Most physically secure as the fibers do not go near the other customers and are not shared.	All traffic is encrypted and the Convergence Node in the pedestal is firewalled. There is also an aspect of physical security as a user's data only goes in one direction around the ring. The closer the house is to the pedestal the more traffic that can be seen assuming the technology and understanding.	Physical security is strong (as the wires do not pass through neighbour's houses). Encryption is generally not used because of this.	Physical security is strong (as the wires do not pass through neighbour's houses). Encryption is generally not used because of this.
Quality of Service	Given that all bandwidth is shared, are there any provisions for prioritizing different kinds of traffic at higher levels than others?	Can be implemented in the upstream (customer to network) direction but downstream priorities are set by the network.	Not really necessary until the traffic hits the wider network 'cloud'	Can be supported around the DSL Ring to the pedestal or throughout the network as a whole. Service Level Agreements can be offered based on traffic priorities so that the network becomes a revenue-generator again.	Most telcos do not implement QoS in these networks as the link to the cabinet is not shared. Unfortunately this means that all traffic is treated the same once it hits the DSLAM.	Most telcos do not implement QoS in these networks as the link to the pedestal is not shared. Unfortunately this means that all traffic is treated the same once it hits the Remote mini-DSLAM.
Multicast Support	Are there any built-in provisions for supporting large broadcast events?	PONs are broadcast media so this can be implemented easily.	Depends on the capabilities of the router that terminates the fibers going to the individual houses. This has little impact on the bandwidth seen by the individual customers.	Can be supported around the DSL Ring to the Convergence Node in the pedestal or throughout the network as a whole.	Depends on the capabilities of the Remote DSLAM that sits in the cabinet. This has little impact on the bandwidth seen by the customer over the copper in this architecture.	Depends on the capabilities of the Remote DSLAM that sits in the pedestal. This has little impact on the bandwidth seen by the customer over the copper in this architecture.
Logistical Criteria						
Infrastructure Re-Use	Deployment timeframes and community disruption are generally lower if the existing infrastructure is being re-used	None	None	Complete	Partial	Partial
Scalability	How does the system scale with the addition and removal of users?	Most PONs are split at less than 1:32 but the split ratios can be up to 1:128 for GPON or 1:32k for EPON. The base rate is 2.488 Gb/s. Basically, PONs subdivide the available bandwidth between the customers who are using the fiber.	The fibers are there and 200+ fiber 'cables' don't cost a lot more than 10 fiber 'cables'. If the number of fibers needed exceeds the fibers in the 'cable', a whole new cable must be laid.	Customers may be added or removed at will while maintaining service to all existing customers.	Whatever bandwidth is available over the fiber is split amongst the several hundred homes served by that cabinet.	Depends on the granularity of the Remote mini-DSLAM that resides in the pedestal. If there are more customers than ports provided by the mini-DSLAM, another box will need to be added. Additional fiber(s) may or may not be required depending on whether Wavelength Division Multiplexing (WDM) is used on the backhaul fiber.

Network Applicability	Can the system be economically deployed on a National basis?	Not economically justifiable to more than an estimated 20% of homes in the USA.	Not economically justifiable to more than an estimated 20% of homes in the USA.	Complete	Not likely to be economically justifiable to greater than 60% of a Nation's population depending on demographics and ROI targets.	Not likely to be economically justifiable to greater than 40% of a Nation's population depending on demographics and ROI targets.
Conclusions						
Stranded Capital Investment	What is the relative potential for capital to be spent and not utilized for revenue generation purposes?	$$$$$	$$$$$+	$	$$$	$$$$
Managed Services	How is the Telco able to provide services that they can charge a premium for?	Carrier has complete control	Only matters in the network 'cloud' as there is really no restriction on the potential bandwidth available to the home.	Carrier has complete control	Only matters from the network to the cabinet as the customer sees a dedicated link.	Only matters from the network to the cabinet as the customer sees a dedicated link.
Rural Application	Is there an economical case to be made for deployment in rural areas?	None	None	Definite application, ROI Timeframe may be somewhat higher than urban application and would benefit from government rural incentive programs	Minimal	None
ROI Timeframe	How long will it take for the upgraded network infrastructure to generate an operating profit? [estimated]	>10 years	>10 years	<2 years	>5 years	>8 years
Risk Profile	What is the risk that the capital spent will not generate a profit for the Telco?	Highest	Highest+	Lowest by far	Middle	High
DSL Rings is Better Because…		DSLR is generally less than 1/10 the cost to deploy in urban areas and 1/100th the cost in rural areas, can be deployed much faster, gives Telcos more time to decide what fiber-based option they really need, can provide POTS when the power fails, etc…	DSLR is generally less than 1/10 the cost to deploy in urban areas and 1/100th the cost in rural areas, can be deployed much faster, gives Telcos more time to decide what fiber-based option they really need, can provide POTS when the power fails, etc…	N/A	DSLR can be deployed in conjunction with FTTN making the FTTN deployment look even better to the consumer. Instead of FTTN, DSLR can be deployed more quickly and economically in far more scenarios/situations.	DSLR can be deployed in conjunction with FTTC making the FTTC deployment look even better to the consumer. Instead of FTTC, DSLR can be deployed more quickly and economically in far more scenarios/situations.