Evolving Migration of Power Distribution – From Under Floor to Overhead

Data centre designers are evolving to meet the demands and complexities imposed by the ever changing business climate of information technology. Industry trends and initiatives are causing stress on current data centre designs. Some such trends are;

- Data centre consolidation
- Server virtualization
- Advancements in processor technologies
- Increasing storage demands
- Rise in data rates
- The desire to implement "green" initiatives

The challenge of increasing power densities and improved cooling strategies are forcing a change in traditional power distribution designs. What once was a static design concept; power distribution on the raised floor has been undergoing significant changes.

As is usually the case, there are alternate methods to meet design objectives. Often, these multiple options lead to debate and controversy rather than harmonious agreement. This is what has been happening in the world of data centre power distribution, where expert opinion is divided on the issue of under raised floor or overhead infrastructure. Although neither method is the end all solution to all situations, it seems that over head power and data infrastructure is gaining significant popularity. In this article we will examine some of the drivers for this evolving migration.

Essentially, the traditional method of power distribution under the raised floor has remained unchanged for many years. Typically, power is distributed to the server cabinets through a series of under floor cable, or whips, which are fed from a distribution panel board. Normally, the panel board is located on the raised floor close to the load in order to reduce the voltage drop in the smaller size conductors. The panel board is normally fed by a secondary breaker typically located in a PDU. The PDU may or may not include a step down transformer, but is normally fed directly from the UPS output. The difficulties with this design are related to the relative inflexibility of the design and the probability of obstructing under floor air currents, thereby negatively impacting

cooling efficiency. As densities rise, new larger cables must be run under the floor to accommodate the increase load, further exasperating the problem.

The emerging alternate method is to feed the cabinets via an overhead track busway system that allows users to quickly insert or relocate plug-in units and electrical power drops. The most flexible busway systems are provided with a continuous open access and allow for power drops to be inserted instantly anywhere along the busway. These designs are generally modular, three-phase systems which consist of electrified copper conductor bars within lightweight housing. Circuits are added or removed through a turn-n-lock insertion process which allows users to insert and remove plug-in units without shutting down power.
The current trend is that more and more data centre designers are opting for overhead power distribution options for their new data centres. The way of the panel board and under floor cables are becoming less prevalent in lieu of overhead power via track busway. Traditional under floor power distribution is becoming less attractive because of its tendency to restrict airflow, inhibit flexibility, and add expense to the price of the server environment. The emergence of over head track busway power distribution allows for an alternative design approach as it eliminates the need for power distribution panel boards and multiple cables. Since track busway connection points include a circuit breaker, there is no need for a panel board. Some designers have gone a step further and completely eliminated the raised floor, which significantly reduces the investment. The availability and acceptance of in row air and water cooling options have made this possible. Of course when there is no raised floor, power must be distributed over head.

Overhead power distribution fits well with key principles of data centre design

Reliability

It is well known that a data center must be designed with the highest level of reliability that the business model or budget allows. Also, since the data centre can essentially never be turned off, it must include provisions for concurrent maintenance and the replacement or change of components without a disruption of power. Flexible over head track busway facilitates ease in change management as it allows circuits to be added or deleted without entry into critical panel boards or PDU's.

Individual circuit additions are made directly to the busway by simply inserting and rotating a plug in unit. Since track busway electrical connections are made via mechanical devices, the chance of mis-wires is greatly reduced. Track Busway also mechanically fixes the physical relationship between conductors, unlike cable where conductors can be in any physical relationship, thereby reducing the chance of

improper phase connections. In some jurisdictions, the use of overhead power and cooling can also eliminate the need for an emergency power off (EPO) button; which is a great source of reliability liability.

Simplicity of design

Human error is a major risk of service interruption, so the simpler the design, the lower the risk of human error related downtime. Over head power provides improved visual circuit management. This improved visual management reduces the probability of inadvertent operation of incorrect circuit breakers. It is nearly impossible to mistake which circuit breaker feeds what load when the cabinet power connection is made directly overhead. Under floor cabling requires cable labels indicating to/from information. It is important that this information be verified at time of commissioning because once load is applied it will be very difficult to tell where a cable originates and terminates, especially when complicated with redundant power distribution systems. Tracing cables under floor tiles is one of the most difficult challenges faced by the data centre manager. Overhead power distribution simplifies this task as cabinet connections are made directly above the served cabinet.

Flexibility

Data centres should be designed for frequent technology refreshing; generally planned at 2.5 to 3 year intervals.

Flexibility to accommodate frequent change without service disruption is mandatory.

Although it is certainly common practice to add or remove under floor circuits, there is considerable risk associated with the activity. Floor tiles must be removed, panel boards dead fronts opened, wires pulled and connected. All activities with appreciable risk associated with them must be considered.

With overhead flexible power distribution systems, circuits are easily added with very little risk to load. Overhead distribution can accommodate varying loads as the main infrastructure is designed to serve high and low density, single and three phase loads from day one. Independent of the type of server used, the systems basic infrastructure remains unchanged.

Scalability

Since most centres will not initially run at full capacity, they must be designed with the ability to accommodate sustained growth without interruption of existing services. Overhead power systems are designed to allow for expansion by simply adding on to the

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existing system or by installation of additional systems. When an additional row of servers is added, simply add another row of over head track busway. If a row is expanded, just expand the track.

Modularity

A modular approach provides a plan for overall capacity utilization in a number of smaller units. Traditional power distribution methods do not lend themselves to modular design concepts as the exact configuration of the load is required at day one. Overhead track busway systems use a basic infrastructure for all loads. Only the plug in unit is specifically configured for the particular load. The basic infrastructure can be added as modules are added and loads connected as they are determined, without changing the track system.

Energy Efficiency

"Greenness": The challenge of operating costs reduction and environmental consciousness is now commonly a design priority. An affordable energy efficient solution is obviously the preferable solution. Over head power distribution systems help improve energy efficiency by improving the cooling efficiency and because shared neutral helps promote material efficiency while phase balancing increases energy efficiency.

This is because removing the under floor cables removes the obstructions which significantly reduces the dampening of airflow in the space underneath the floor. Placing anything, including cables will deflect, slow down, or stop airflow. By reducing the airflow dampening, the total amount of airflow remains unchanged, however the distribution of airflow is significantly improved.

Cable obstructions normally make the air distribution very non-uniform, creating pressure differentials that can lead to data centre hot spots. Suppose that in a certain area of the under-floor space, the flow from the CRAC is moving perpendicular to a mass of cables. As the flow goes over the cables, the pressure varies rapidly. Upstream of the cable, the pressure builds up; then it falls abruptly as the air goes downstream of the cable. If you have perforated tiles in the upstream and downstream regions, you will get large airflow through the upstream perforated tile and low airflow in the downstream perforated tile. Thus, a server rack placed in the downstream region can be starved of cooling air and may overheat. If you remove the cable obstructions, this non-uniformity will go away.

Over head power also mitigates the single biggest offender in the waste of cooling efficiency which is improperly sized raised floor penetrations for cabling that allow bypass air. Although the use of proper airflow management, including seals, brushes, air dams and other accessories can help control bypass air; it becomes a non-issue when

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power is delivered overhead. Under floor cabling also requires that the tiles be removed during circuit additions. This can significantly decrease static pressure during the time of circuit addition.

In some cases, it is possible to gain Leed's points with overhead track busway as it can be defined to meet the requirements of sustainability (reusable), adaptability (ease of change), scalability (expandable without modification), and energy efficiency (cooling waste reduction).

Conclusions

The final selection of either an under floor or an overhead power distribution system is a balance between construction specifics, operational metrics, physical constraints, and the evolutional demands of the enterprise. That final selection will have to survive the ever changing shape of the environment IT supports. In the end, it can be said that there are reasons for installing both under floor and over head power systems in the data centre. Both have their own set of advantages and limitations which have to be taken into account while choosing either of them. Nevertheless, as a general trend, under floor power distribution and subsequently even raised floors are giving way, to overhead track busway power solutions along with a growing number of solid floor designs.

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