Western Michigan University – Office of Information Technology & Campus Planning, Design & Construction

Design Guidelines for Facilities Construction:

DESIGN GUIDELINE DG17-8 WIRELESS ETHERNET SYSTEM

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I. GENERAL DESCRIPTION

All WMU buildings are to be equipped for wireless Ethernet LAN data access for mobile users in all internal areas and outside areas where students are likely to congregate or study or where access may be useful to staff performing their duties.

The University's intention is to stay current in the wireless technologies offered in new buildings or renovations. Wireless technology is evolving very rapidly. At this writing, new wireless installations will support IEEE 802.11a and 802.11g standards.

Installation of a full wireless system involves placement of "access points" (APs) – basically two-way Ethernet radio systems complete with multiple antennas- at a sufficient number of points in the building to assure full coverage. Access points for outside coverage are generally mounted inside the building and connected to an outside antenna.

While wireless technology has advanced greatly in the past few years, wireless connectivity will remain much inferior to wired connections. Wireless coverage in buildings is intended for mobile users and is considered clearly inadequate to replace wired connections for users who have continuing need for communications access of any sort at a relatively fixed location.

Wireless technology has progressed to the point that it may be considered for use for backup links for inter-building communications system backbone links. Such links increase the reliability the increasingly critical communications connectivity for the building and the University as a whole. The possibility of installing one or more such links should be considered and discussed with WMU

OIT and Campus Design early in project development. Such links require outside access points that may be moderately different from those dedicated to user support.

II. GENERAL DESIGN CONSIDERATIONS

Wireless technology has advanced greatly in the past few years. However, wireless connectivity is less secure and reliable and still much slower than wired connections. Wireless coverage in buildings is intended for mobile users with no "permanent" location in the building or for building occupants who need connectivity away from their customary work location for relatively short periods. It is not intended for and is considered clearly inadequate to replace wired connections for users who have continuing need for communications access of any sort at a relatively fixed location.

As of this writing, the standard interior access point is the Cisco 1200 series. This unit has separate RF sections and antennas for both IEEE 802.11a and 802.11g in a single plenum-rated box with a single Ethernet connection and a console port. It can be configured to support either 802.11 technology or both, either as ordered or through field changes. A variety of APs may be used for outside access.

Installation of a full coverage wireless access system presents several special challenges.

- The technology, products, and resulting capabilities at several levels are evolving very rapidly. This makes it difficult during design stages of a project to address specific equipment and the corresponding system layout that will be current at the time of installation.

- Wireless equipment uses very high radio frequencies (RF) at very low power for two-way communications. This has a significant impact on project definition and design:

    - Such signals can be affected in marginally predictable ways by many building components. As a result, the exact placement of wireless access points cannot be accurately determined until the building is substantially completed and an RF survey can be completed. This makes the definition of detail specifications of locations and other associated required facilities and work very difficult to define accurately, complicating the preparation of bids and responses.

    - This aspect of the design is further complicated by the fact that the currently accepted standard uses two different radio frequencies, 2.4 GHz and 5.5 GHz. APs used by the University can support either or both technologies in a single unit. FCC regulations allow the low frequency to have remote antennas, but constrain the higher frequency antenna to be incorporated into the AP. Due to the wide difference in the frequencies, the coverage areas for the two are dramatically different and the transmission/reflection effects of nearby materials may be quite different.

- Software is beginning to come available which is designed to assist in the design of wireless systems based on drawings and material specifications of buildings. The degree of effectiveness of the software has yet to be proven at the time of writing. However it is possible such software could assist in design of wireless systems.

In recent projects, the University has attempted to address these challenges in various ways. The basic concept has been to attempt to define the expected locations of wireless access points on the communications outlet drawings and then require the contractor to perform a Cisco-approved-style wireless survey of the nearly completed building in order to define the final design. The following paragraphs attempt to define in more detail some of how this has been handled.

- To compensate for the difficulty of assuring the best current equipment is installed in a project that may have been contracted up to two years before installation, the University has supplied the wireless access point units, removing the burden of their selection and cost from the contractors.

- Similarly, the University has supplied antennas to be used with the access points. In most cases, this is straightforward since antennas for most APs can be standard. Complications occur when the wireless survey indicate that a specialized antenna system is required at some locations to meet special situations or purposes. Outside locations automatically fall into this category. Contractors and the University have had to collaborate in dealing with these situations.

- In order to provide a defined quantity of access points and a general feel for their distribution at the time of bid, AP locations have been placed on drawings along with other outlets. The locations shown are based on a “best guess” design based on several considerations:

  - Study of documents available from Cisco and others discussing the design of such systems. Evaluation of the performance and other experience of existing systems at WMU and other locations.

  - Rated coverage area (diameter) for each of the frequencies/standards. Since the coverage area for 2.4 GHz is significantly larger than that for 5.5 GHz, this normally results in a patterned system where one set of APs are expected to support both frequencies and others to support only one in order to fully cover all areas with both using a minimum number for the lower frequency. (The generally published design criteria shows a 9:1 ratio in large areas with no RF anomalies. While the situation seldom exists, this illustrates the cost savings involved in not simply making all APs dual-frequency. The University has found closer to a 2:1 or 3:1 ratio in real buildings with added considerations.)

  - Best guesses as to the effects of walls, elevators, etc. on the RF radiation pattern and losses. In the past, these have been strictly educated guesses based on experience with previous systems. Some objective data on effects of walls and objects that may be able to introduce some engineering into this process.

- Attempts to provide an adequate quantity of APs for projected loads. APs are generally considered adequate for up to 20 users. This can present special challenges in classrooms and especially lecture halls where it may eventually be necessary to support a high percentage of the students using wireless devices. In such areas the relatively large quantity of APs required based on load can result in large overlaps of signal and channel coverage. Initial design simply has shown mainly the projected quantity of AP outlets and the overlap problems must be addressed by the survey and a final design possibly using directional antennas, reduced power levels, and other techniques in addition to refinement of AP locations.

- Any other special situation connected with the particular project design that could be expected to have an impact on the location or quantity of APs in the wireless design.

- The bid document has been required to use creative language to adequately describe the challenges involved and define the scopes for the contractors and the degree of University involvement. WMU OIT has been heavily involved in all wireless system design and specification as our procedures have evolved over several projects.

Horizontal copper cable outlets intended for support of wireless access points need to be defined early in the design cycle and refined as building design progresses. They are generally placed above ceilings or at other points at locations which must be defined based on a general understanding of the RF effects of building construction and past experience. OIT should be consulted in the placement of these outlets.

Program projections of wireless use will influence the design of the system, especially in assuring that instructional spaces have adequate coverage if intensive wireless use is anticipated. These needs must be considered in design of the overall system.

III. DESIGN REQUIREMENTS

A. General

The wireless system will use Cisco access points and will conform to Cisco standards.

As of writing, wireless system will support IEEE 802.11a and 802.11g standards using Cisco AIR1200 series access points. Any new relevant Cisco products and IEEE standards approved will be considered for rapid adoption. Consult WMU OIT for specific products level of support planned for implementation in specific projects.

Whenever possible, access points will be powered through the network connection using power over Ethernet (POE).

B. Access Point Outlets

Horizontal cable system outlets for access points should be specified as part of the horizontal copper system in the drawings. Locations indicated should be at points believed appropriate, but designated as wireless-style outlets and subject to change as a result of the required survey. Guidelines for choosing locations include:

- Access points should be located to be relatively inconspicuous and inaccessible to the general public (for security), but accessible by maintenance personnel. This may include above ceilings, high on open walls, behind RF permeable trim. RF permeable security boxes are acceptable when appropriate and acceptable to interior architects.

- It is assumed that most APs will be installed with standard dual 2.5GHz “rubber duck” antennas and/or standard

- Locations should be central for large area, low-density coverage, and focused for high-density coverage.

- Enough locations should be included to ensure proper coverage for the lowest capability devices. The RF survey may indicate some proposed locations are not required. (This is felt to be better than being required to add locations as the result of the survey.)

- Locations for points to support external access should be defined. See guidelines applying to outside access in this section.

Outlets for access points should have two jacks: one white (for POE) and one yellow. The second jack will normally be used for AP console access, but will be available for a second AP is found to be required by the survey.

AP Outlets and AP installations may take different forms:

- Standard outlet box and faceplate with AP mounted nearby and connected by standard jumper(s). The Cisco bracket currently included can be mounted to walls or other fixtures.

- An open box with the AP bracket mounted directly to the box. The horizontal jacks use no faceplate and are attached to the AP with very short jumpers.

- Others, as dictated by local conditions or contractor preferences, subject to WMU approval.

C. Site Survey

Installation contractor is to be responsible for conducting a Cisco-approved site RF survey of the entire building interior to finalize the wireless system design including:

- Selection of specific access point locations to be activated for 2.4 GHz and 5.5 GHz.

- Any special antenna requirements to optimize RF coverage patterns in special situations.

- Channel assignments and power levels for each access point to provide best coverage with minimal potential interference.

- Define any required support structure for access points and brackets, antennas, etc.

The site survey must be done after the completion of all internal walls and substantial completion of all other internal systems to have validity. The survey and design should take into account both presence of coverage (vs. "not covered") and adequacy of coverage to support the expected or possible density of users, especially in classrooms or other instructional areas.

All occupied areas of the building are to be covered for all technologies (currently IEEE 802.11a and 802.11g) with a signal quality of good or better on the survey instrument.

- The following areas are excluded from this requirement:

    - Rest rooms
    - Elevator cars
    - Stairwells

- The following areas need have only good (not necessarily full) coverage for 802.11g:

    - Mechanical rooms.
    - Electrical substations
    - Other large maintenance-type support-only areas.
    - (Note: CDRs and BEF should have full coverage)

Contractor is to produce proposed design drawings with the above information for approval by WMU OIT before starting actual installation.

D. General Outside Wireless Coverage

For projects in areas where outside wireless coverage is not already full or where current coverage is disrupted, outside antennas should be installed to provide coverage for the area surrounding the project.

Area to be covered and locations for outside antennas should be selected in consultation with WMU OIT and other interested parties.

The normal general access outside coverage location supports only 2.4 GHz 802.11g and consists of the following:

- An antenna mounted outside the building, oriented to cover the desired area.
- A coaxial cable from the antenna passing into the building and connected to the access point.
- Properly grounded lightning arrestor for the antenna.
- Access point connected to the communications system.

At the selected locations, the following needs to be provided:

- Weather-tight pass-through of 1” or larger for cable egress.
- Mounting pole or bracket for an antenna or AP-antenna combination in close proximity to the pass-through.
    - Any of a variety of mounts can be acceptable. Generally a pole of approx. 1 ½ in. diameter and 1-2 ft. length is required for the actual mounting hardware.
- Access point communications outlet and mounting location.
- Ground connection location if building ground is to be used.

The following considerations should be taken into account in the design and locating of the mounting system:

- Appearance.
- Accessibility/maintainability after completion of the installation.
- Resistance to weather effects, both against damage and for long-term appearance considerations.
- Ability to locate an access point and grounded lightning arrestor near the inside opening of the pass-through.

E. Point-to-Point backup links

For point-to-point backup links, points at the top of the project building will be selected in conjunction with appropriate line-of-sight points on existing buildings that can act as backup support sources. The system should be designed in conjunction with WMU OIT and others.

The Cisco bridges that would probably be used for this link require a special dual-coax cable from the outside unit direct to the nearest CDR.

F. System Installation

Wireless contractor will coordinate with electrical and other contractors to assure outlet boxes, communications circuits, mounting brackets for AP and antenna, etc., as required are placed to properly support the final system design.

Owner will provide Cisco access points (with Cisco-supplied mounting brackets only) and antennas as required by the final design.

Contractor will install required access points and mounting brackets, if used.

Contractor should install jumpers to outlets so they can be activated by installation only of appropriate jumper in CDR. Normally, AP Ethernet connection will be connected to white jack and AP console port will be connected to yellow jack.

IV. PRODUCTS

Cisco Access points will be supplied by WMU unless otherwise specified.

- As of writing the AP1200 series is used.
- When included, Cisco mounting brackets will also be supplied by WMU.

Antennas and extension cables as required may be supplied by WMU if required.

WMU normally supplies Cisco brand RP-TNC lightning arrestors with crimp lugs for ground wires.

Cables to connect outside 2.4 GHz outside antennas are Times Microwave LMR-400 black plenum cable with appropriate connector for antenna on outside end and RP-TNC plug on inside end.

The current general-purpose large area outside antenna most used by WMU is Maxrad model MSP24013-120. Other antennas have been used and may be preferable, depending on situation.

Currently, point-to-point links would use the Cisco AIR-1410 802.11a directional bridges.

END OF SECTION