OLYMPUS

Subject:	Proposal for fluorescence images and whole slide images
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Proposal for fluorescence images and whole slide images:

1. Images have there own UID's (unique identifier, image ID) and are separated by Study UID's and further more in Series ID's
   => so everything which belongs together has the same StudyID and SeriesID (DICOM Part 3, p.52 (fig.7-1a). This is actually used by CT/MRT-series (e.g 3D stacks) where every section is a single image and is saved VIA DICOM as a separated image.
2. for CT/MRT images there is the "Table Position" tag (0018,9327) to identify the exact position of the image within the stack

⇨ for virtual slides (whole slide images) and for fluorescence images a similar structure should be used to distinguish between the different "dimensions" within one series:

a. for fluorescence:
   i. stage position, a new tag of the type=FD with VM=3 (x,y,z)
   ii. a tag for the wavelength (or we use 0022,0001)
   iii. in addition to the wavelength a tag for the fluochrom to be named with the type=CS with VM=1
b. for whole slide images
   i. in the same way like a. i. (stage position)
   ii. a new tag for the level of the pyramid, e.g, "Image Pyramid Level", type=US (0022,….) -> see DICOM part 6, pp34

Explanation of pyramid structure:

1. all whole slide images (virtual images) are internally structured in a pyramidal format. This has the benefit that individual "areas" with a specific "magnification" can be loaded very fast.
   Figure 1 and figure2 should give you an example with 3 levels (there should in be general no limitation of levels) of a pyramid structure:

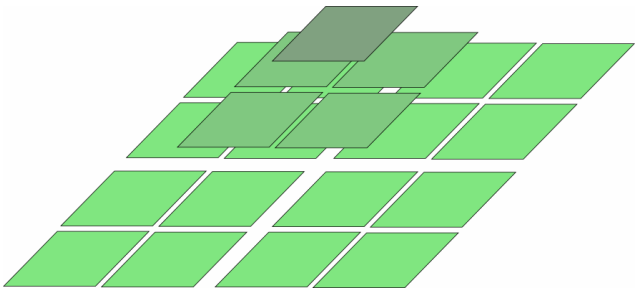

Figure 1 structure how to address the different levels

Figure 1 has 16 tiles in level 0 (100%). The next level, level1, is made out of 4 tiles -> combining 4 tiles from level 0 to 1 new tile, resulting in 4 new tiles. The next level, level 2 has only 1 tile left. It is again created by combining 4 tiles to 1 new tile. As there are only 4

tiles left in level1 the level 2 has only 1 tile and the pyramid is finished. It is important that always 4 tiles form level *k* are creating a new tile in level *k+1*. The number of levels must not be defined and depends on the “resolution” and tile size of level0 (100%) only. The tile size of course should be of the size width=height=2^n. This is not necessarily needed but would make the image reconstruction for the viewers easier. The tiles should not be too small otherwise one slide is divided up in too many tiles (there is no need of a restriction of the tile size). Of course tiles at the border are normally smaller.

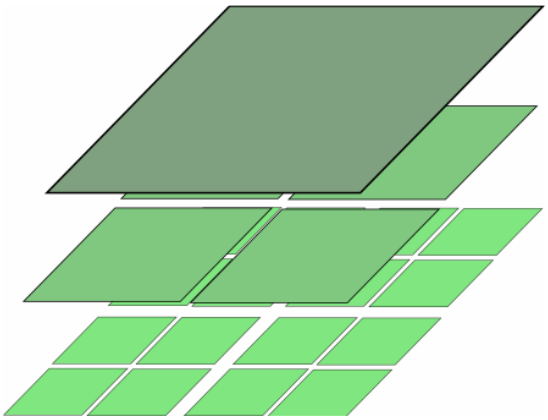

Figure 2 : “area” which is covered by the different levels

Figure 2 shows the tiles of the pyramid in comparison with the area which is covered by the individual tiles. 4 tiles of level 0 are combined to 1 tile in level 0 => so in level 0 sixteen tiles are covering the whole slide and in level1 four tiles are covering the whole area (“lower magnification”). With this figure you should see how easy the stage coordinates or table coordinateds have to be coded with respect to level 0.

Conclusion:
The whole slide images should be sent as individual images (tiles), like stacks in CT/MRT, to the server. The images (tiles) are “coded” as described above. There is no specific structure needed in addition.

- ⇨ huge benefit NO new file format or protocol (like JPIP) is needed. The tiles must fulfill the existing standard of DICOM concerning compression etc. All vendors of virtual slide scanners can easily divide the wsi into tiles and send single images with the above described tags to the DICOM server. The DICOM viewer must “learn” how to build up an image from these tiles, which is not difficult.