Principles of Ad Hoc Networking

Michel Barbeau and Evangelos Kranakis

May 4, 2007
A set $P$ of points in the plane
$q$ is the nearest neighbor of $p$
The lune defined by points $p$ and $q$
The circle with diameter the line segment determined by $p, q$ and centered at the point $\frac{p+q}{2}$
When is a point $X \in \{C, D\}$ inside the circle
Proving the planarity of GG
Triangulation of a pointset
Proving that MST is a subset of RNG
RNG is a subset of GG
Proving that GG is a subset of the DT
Eliminating an unnecessary link (dashed line $AB$) with the Gabriel test
Applying the Gabriel test
Defining the geometric regions of the Morelia Test
Examples of the Morelia test situations

\[a)\]

\[b)\]

\[c)\]
Example of selection of the neighbors of $u$ in the Half space proximal test
Proving that the Half space proximal test produces a graph of degree at most 6
Proving that the Half space proximal is not planar
The irregular transmission area of node $u$
Path $p$ from $u$ to $v$
A planar graph over which compass routing fails to find the destination
Face routing on a planar graph
An example of a quasi-planar subdivision that satisfies the Left-Neighbor Rule
Illustration of basic functions on quasi-planar subdivisions
Circled numbers represent the ordering on outgoing edges, squared numbers on ingoing ones.
The ingoing edge \((y, u)\) is third, the chosen outgoing edge \((u, x)\) is also third.
The dashed part of the outer face represents the vertices in $V_\cap(x, y, z)$ and the bold solid part represents vertices in $V_\cap(x, y, z)$, respectively.
A sensor at $A$ not equipped with a GPS device can determine its position from the positions of its three neighbors $B_1, B_2, B_3$. 

A circle with center at $A$ and radius $d(A,B_1)$ intersects with two other circles centered at $B_1$ and $B_3$. The points of intersection are $B_2$ and $B_3$.
The TDOA technique

\[ A(x, y) \]

\[ B_1(x_1, y_1) \]

\[ B_2(x_2, y_2) \]

\[ B_3(x_3, y_3) \]
The AOA technique

\begin{center}
\begin{tikzpicture}
\draw[thin,dashed] (-5,0) -- (5,0) node[midway] {\textit{reference axis}};
\draw[ultra thick] (-3.5,0) -- (-1.5,2) node[pos=0.6,above] {$A$};
\draw[ultra thick] (-3,0) -- (-1.5,-2) node[midway,above] {$\phi_1$};
\draw[ultra thick] (-1.5,2) -- (2.5,-2) node[midway,above] {$\phi_2$};
\draw[ultra thick] (-1.5,-2) -- (2.5,2);
\filldraw[ultra thick] (-1.5,0) circle (3pt) node[below] {$B_1$};
\filldraw[ultra thick] (2.5,0) circle (3pt) node[below] {$B_2$};
\end{tikzpicture}
\end{center}
Application of 3-NA will equip node $A'$ with its $(x, y)$-coordinates, but it fails to do it with node $A$
A sensor not equipped with a GPS device can determine its coordinates using the positions of two neighbors $B_1$ and $B_2$ and their neighborhood information.
The termination condition for the 3/2-NA
$n$ points on a unit interval and three intervals of identical length
$n$ sensors thrown randomly with the uniform distribution on a unit interval
Covering a unit square with disks
Partitioning a unit square into subsquares with side $s_n$
A circle of radius $R$ within the coverage range of the sensor at $A$. 

\[ r = \frac{\alpha}{4}, \quad d = \frac{R}{K} \]
Covering a given circle at $A$ from a sensor within the strip, with high probability
Decomposition of the unit square region (square with thick perimeter) with smaller overlapping circles of equal radius
Partitioning of the unit square region (square with thick perimeter) with smaller circles of equal radius
The $\alpha$-lune defined by points $p, q$ and the parameter $\alpha$